Report

# Wastewater Treatment Plant Anaerobic Digestion Study

**City of**

## Whitewater, WI

May 2010

Report for

# City of Whitewater, Wisconsin

## Wastewater Treatment Plant Anaerobic Digestion Study

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# SECTION 1
# INTRODUCTION AND BACKGROUND

## 1.01 INTRODUCTION AND BACKGROUND

### A. Wastewater Treatment Facilities

The City of Whitewater operates wastewater collection and treatment facilities that provide service to City residences, businesses, industries, and public institutions within the City. The current facilities at the wastewater treatment plant (WWTP) were placed in operation in 1982. The last major renovation of the facility was completed in 1996. An equipment replacement and rehabilitation project has been designed and will be constructed in 2010 to address some of the aging equipment.

The WWTP consists of the following unit processes: influent pumping, preliminary treatment (screening and grit removal), primary clarification, rotating biological contactors (RBCs), secondary clarification, filtration, disinfection by chlorination/dechlorination, and postaeration. Phosphorus is removed from the wastewater at the secondary clarifiers by adding alum. The chlorination/dechlorination system will be replaced with ultraviolet (UV) disinfection as part of the 2010 project. Treated wastewater (termed "effluent") is discharged to nearby Whitewater Creek.

Solids that settle in the primary and secondary clarifiers are cothickened in the primary clarifiers and then stabilized using anaerobic digestion (AD). The end product is liquid digested sludge (termed "biosolids"). The City uses the former secondary digester for biosolids thickening and storage during the winter and other times when conditions are not favorable for land application. Thickening is done by pumping supernatant off the top of the biosolids in the storage tank and discharging the supernatant to the plant sewer for treatment in the WWTP. The City is required to maintain at least 180 days of biosolids storage on-site. This storage is normally provided by the former secondary digester; which presently has about 360 days of storage capacity. The spare primary digester capacity can also be used for biosolids storage if needed. The City uses its own equipment and personnel for land application of stabilized, liquid biosolids onto agricultural fields, and this program has been successful.

The WWTP was originally sized to handle a design average flow of 3.65 million gallons per day (mgd) and a design average biochemical oxygen demand (BOD) loading of 11,400 pounds per day (lb/day). Because of the closure several years ago of a major food processing industry, the WWTP currently only treats about half of the design flow and a fifth of the design BOD loading. As a result, fewer biosolids are produced than were originally anticipated, and only one of the two primary digesters is presently in use. This digester (No. 1) will be rehabilitated as part of the 2010 project and new recirculation and mixing equipment provided. Primary Digester No. 2 is idle and may be alternated with Digester No. 1 for short periods of time, for example, if Digester No. 1 is in need of cleaning or repairs.

### B. Anaerobic Digestion and Biogas Utilization

The AD process creates conditions favorable for anaerobic microorganisms to convert organic matter to carbon dioxide and methane. The carbon dioxide and methane are collectively termed "biogas." Biogas at the Whitewater WWTP was formerly compressed and stored in a sphere, from which it could be used to fuel a boiler for digester and building heating. The equipment that was once used for biogas utilization is now in disrepair and all but the storage sphere will be removed or replaced as part of the 2010 project.

When biogas is utilized for heat or electricity production, the process is considered "carbon neutral" because the methane was generated from recent, natural sources and its use offsets the need for fossil fuels. At Whitewater, all of the biogas produced in the AD system is currently burned in a flare with no heat or energy recovery; this produces carbon dioxide which is released to the atmosphere. While flaring the biogas is more favorable from a greenhouse gas (GHG) emission perspective than methane emissions would be, it is not considered carbon neutral. Natural gas is purchased for digester and building heating at an annual cost of approximately $60,000 (2007 and 2009) to $70,000 (2008 budget). The total natural gas use is about 60,000 to 70,000 therms per year or about 19.2 million British Thermal Units (MMBTU) per day average. We Energies supplies the WWTP's natural gas and electricity.

C. Purpose of Study

The City is engaged in a WWTP facility planning process that will explore overall treatment and biosolids stabilization alternatives for approximately 20 years. Parallel to that study, and because of the age of and spare capacity in the existing AD facilities, the City is exploring options for AD of agricultural or industrial wastes using the spare capacity in Digester No. 1 and/or Digester No. 2. In addition, the City recognizes the importance of evaluating alternatives for biogas utilization because of the high cost of natural gas and the desire to reduce its carbon footprint. This study specifically addresses the future use of the AD facilities and biogas utilization.

This study was funded in large part by grants from Focus on Energy and We Energies.

## 1.02 LOCATION OF STUDY

Figure 1.02-1 shows the sewer service area, Whitewater city limits, and WWTP location. The City is located in northwest Walworth County and southwest Jefferson County in southeastern Wisconsin.

## 1.03 RELATED STUDIES AND REPORTS

The following reports were used in the preparation of this study.

A. *Wastewater Treatment Facilities Evaluation*, Strand Associates, Inc., March 1995.

B. *Sanitary Sewer Service Area for the City of Whitewater,* Southeastern Wisconsin Regional Planning Commission, March 1995.

C. *Amendment to the Regional Water Quality Management Plan for the City of Whitewater,* Southeastern Wisconsin Regional Planning Commission, September 2003.

D. *Whitewater Wastewater Treatment Plant Energy Survey Report,* Focus on Energy, June 2003.

E. *Community Manure Management Feasibility Study–Dane County, WI*, Strand Associates, Inc., February 2008.

F. *Community Manure Management Facilities Plan–Dane County, WI*, Strand Associates, Inc., March 2009.

G. *Wastewater Treatment Plant Equipment Replacement and Rehabilitation*, Strand Associates, Inc., May 2009.

H. *City of Whitewater Wastewater Treatment Plant Facilities Plan*, Strand Associates, Inc., Draft, 2009.

## 1.04 RELATED DRAWINGS AND SPECIFICATIONS

The following drawings and specifications were used in the preparation of this study.

A. *City of Whitewater Wastewater Treatment Plant,* prepared by R.A. Smith and Associates, 1979.

B. *Wastewater Treatment Plant Modifications*, prepared by Strand Associates, Inc., 1995.

## 1.05 DEFINITIONS

The following abbreviations are provided as an aid to the reader:

| | |
|---|---|
| AD | anaerobic digestion |
| AU | animal unit(s) |
| avg | average |
| $BOD_5$ | five day biochemical oxygen demand |
| BPR | biological phosphorus removal |
| BTU | British thermal unit |
| CAFO | concentrated animal feeding operation |

| | |
|---|---|
| cfm | cubic feet per minute |
| cfs | cubic feet per second |
| COD | chemical oxygen demand |
| col/100 mL | colony forming units per 100 milliliters |
| cfu/gTS | colony forming units per gram total solids |
| CPR | chemical phosphorus removal |
| CWF | Clean Water Fund |
| DO | dissolved oxygen |
| ft | feet |
| $ft^2$ | square feet |
| $ft^3$ | cubic feet |
| GHG | greenhouse gas |
| gpd | gallons per day |
| gpm | gallons per minute |
| hp | horsepower |
| HRT | hydraulic retention time |
| in | inches |
| ITA | Intent to Apply |
| K | potassium |
| kwh | kilowatt-hours |
| lbs | pounds |
| lf | linear feet |
| mil gal | million gallons |
| mgd | million gallons per day |
| mg/L | milligrams per liter (parts per million in dilute solutions) |
| min | minutes |
| MMBTU | million British Thermal Units |
| mo | month |
| MPN | most probable number |
| MT | microturbine |
| N | nitrogen |
| NFPA | National Fire Protection Association |
| $NH_3N$ | ammonia nitrogen |
| $NO_2N$ | nitrite nitrogen |
| $NO_3N$ | nitrate nitrogen |
| NRCS | Natural Resources Conservation Service |
| O,M,&R | operation, maintenance, and replacement |
| P | phosphorus |
| PE | Population Equivalent |
| PERF | Priority Evaluation and Ranking Form |
| PRS | primary sludge |
| ppbV | parts per billion on a volumetric basis |
| ppd | pounds per day (or lb/day) |
| ppmV | parts per million on a volumetric basis |
| psi | pounds per square inch |
| psig | pounds per square inch gauge |

| | |
|---|---|
| RBC | rotating biological contactor |
| scfm | standard cubic feet per minute |
| SRT | solids retention time |
| SS | suspended solids |
| SSL | secondary sludge |
| SWD | side water depth |
| TKN | total Kjeldahl nitrogen ($NH_3N$ plus organic N) |
| TN | total nitrogen (TKN plus nitrate) |
| TS | total solids |
| TSS | total suspended solids (or SS) |
| μg | micrograms |
| μg/L | micrograms per liter (parts per billion in dilute solutions) |
| USDA | United States Department of Agriculture |
| USEPA | United States Environmental Protection Agency |
| USGS | United Sates Geological Survey |
| UV | ultraviolet |
| VS | volatile solids |
| VSS | volatile suspended solids |
| WAC | Wisconsin Administrative Code |
| W.C. | water column |
| WDNR | Wisconsin Department of Natural Resources |
| WPDES | Wisconsin Pollutant Discharge Elimination System |
| WWTP | wastewater treatment plant |

The following definitions are provided as an aid to the reader:

Aerobic digestion–Microbial decomposition of organic matter to carbon dioxide and water in the presence of oxygen.

Anaerobic digestion–The microbial decomposition of organic matter to carbon dioxide and methane in the absence of oxygen.

Anoxic–A condition in which dissolved oxygen is not available and other forms of oxygen, such as $NO_3$-oxygen $SO_4$-oxygen, are used by microorganisms to decompose organic matter.

Biogas–As used in this study, carbon dioxide and methane produced in the anaerobic digesters. Also contains small amounts of other compounds such as hydrogen sulfide.

Biosolids–The nutrient-rich organic materials resulting from the treatment of wastewater. As used in this study, biosolids consist of digested primary and secondary sludge.

Carbon neutral–Not causing a net increase (or decrease) in carbon emissions; utilization of biogas is considered carbon neutral because the carbon was from a recently created, renewable source and use of biogas offsets the use of fossil fuels.

Mesophilic–Occurring at a temperature of approximately 95°F (35°C).

Nitrification–Aerobic conversion of ammonia to nitrate by microorganisms.

Population Equivalent (PE)–A term used to compare nonresidential wastewater flows and loads (i.e., commercial, industrial, institutional) to the number of people that would generate an equivalent amount of wastewater. Generally, flow is used to determine PE at a residential equivalent flow of 100 gallons per day (gpd). Thus, 1,000 gallons of commercial or industrial flow would represent a PE of 10.

Sludge–Concentrated organic solids produced during wastewater treatment (also termed "biosolids" when secondary sludge is included).

Thermophilic–Occurring at a temperature of approximately 131°F (55°C).

Volatile solids–Portion of the wastewater or manure solids that is destroyed at temperatures above 550°C and is an indicator of the organic fraction of the total solids.

# SECTION 2
# CURRENT CONDITIONS

## 2.01 DESCRIPTION OF EXISTING FACILITIES

### A. Facilities Description

An aerial photo of the existing WWTP is shown in Figure 2.01-1. Figure 2.01-2 presents a schematic drawing of the existing WWTP including the AD system. The AD unit design criteria are listed in Table 2.01-1 along with relevant heating systems and information about the WWTP's emergency power system.

At the WWTP, raw "influent" wastewater is pumped to a mechanically cleaned bar screen. Screened wastewater flows to a vortex grit collector. This process removes grit from the influent before introduction to the primary clarifiers. Screenings and grit are dewatered and landfilled.

The influent wastewater flow is split between two primary clarifiers. In these units, settleable solids are removed by providing an area of quiescent settling. Primary clarifier effluent flows to the RBC units.

Biological treatment occurs in the RBCs, which are housed in three buildings. Each building contains two trains of eight RBC units. RBC effluent flows are split between two secondary clarifiers at a division box. Phosphorus removal chemical (alum) is added to the RBC effluent upstream of the secondary clarifiers in the division box.

Secondary clarifier effluent flows to a four-cell gravity filter. This unit serves to remove additional solids from the secondary effluent before entering the chlorine contact tank. Solids are discharged to the plant sewer that flows into the WWTP influent pumping station wet well.

Chlorine solution is added in the chlorine contact tank for disinfection of treated effluent. To dechlorinate, sulfur dioxide is added near the end of the chlorine contact tank to react with the remaining chlorine residual. This system will be replaced with UV disinfection in 2010. Effluent from the chlorine contact tank flows to the postaeration tank where air is added to increase dissolved oxygen levels above discharge permit requirements.

Secondary sludge (SSL) that settles in the secondary clarifiers is pumped into the primary clarifier division box. This serves to cothicken the secondary solids along with the primary solids in the primary clarifier. Cothickened primary sludge (PRS) and SSL are withdrawn from the bottom of the primary clarifiers and pumped directly to one of two primary anaerobic digesters. Secondary sludge can also be pumped directly to the primary digesters without cothickening, if desired.

The primary anaerobic digesters provide an environment where organic matter is digested and the solids stabilized. Volatile solids (VS) are destroyed and pathogens are significantly reduced in this process. Digested sludge is transferred to the former secondary digester, now referred to as the sludge storage tank, for storage. Digested sludge is thickened by supernating (withdrawing the upper layer of clearer liquid) from the sludge storage tank after solids have had a chance to settle. Supernatant is pumped to the plant sewer and returned to the influent pump wet well for treatment. Sludge from the storage tank can be loaded onto trucks at the liquid sludge loading station. Digested sludge is field-applied directly in liquid form. Biogas produced by the digesters is flared (burned and released to the atmosphere) at a waste gas burner.

## TABLE 2.01-1

## ANAEROBIC DIGESTION AND WWTP GENERATOR UNIT DESIGN CRITERIA

| Unit Process | Design Criteria |
|---|---|
| | |
| **Primary Anaerobic Digesters** | |
| Number | 2 |
| Type | Heated, Mixed |
| Size, each | 60-foot-diameter x 25 feet SWD |
| Volume, Total | 157,000 cf (1,170,000 gal) |
| | |
| **Secondary Anaerobic Digester/Sludge Storage Tank** | |
| Number | 1 |
| Size, each | 85-foot-diameter x 25 feet SWD |
| Volume, Total | 157,000 cf (1,170,000 gal) |
| | |
| **Biogas Waste Gas Burner** | |
| Number | 1 |
| Capacity | 144,000 cf/day |
| | |
| **Biogas Storage Sphere (Not Currently Used)** | |
| Size, diameter | 35 feet |
| Volume | 180,000 cf |
| | |
| **Digester Heating System** | |
| Number of Boilers | 2 |
| Size, each | 4,500 MBH input, 3,600 MBH output |
| Fuel | Natural Gas (30-in. W.C.) |
| Number of Heat Exchangers | 3 |
| | |
| **WWTP Emergency Generators** | |
| Number | 2 |
| Size, each | 300 KW |
| Fuels | Natural Gas (1.5 to 3 psi) and Diesel |

B. Condition of Existing Facilities

The WWTP staff was interviewed, and the existing AD facilities were reviewed on several occasions in 2008 and 2009. Table 2.01-2 provides a summary of the known condition or deficiencies in the AD facilities. When applicable, recommendations are also provided. Several of the deficiencies are being addressed as part of the 2010 project, and this is indicated by "(2010)" in the Recommendations column.

## 2.02 CURRENT INFLUENT LOADINGS AND BIOSOLIDS PRODUCTION

From 2004 to 2007, the influent five-day biochemical oxygen demand ($BOD_5$) and total suspended solids (TSS) loadings averaged 2,120 and 2,520 lb/day, respectively. The design $BOD_5$ and TSS loadings for the existing plant are 11,500 lb/day and 10,800 lb/day, respectively. Therefore, the plant design loadings have not been exceeded, and the plant is loaded at about 18 percent of the BOD capacity and at about 23 percent of the TSS capacity.

The reported 2007 average PRS and SSL pumped to the anaerobic digesters was 6,130 gallons per day (gpd). With one digester in use, this results in a primary digester retention time of 96 days. The Wisconsin Administrative Code (WAC) and other sources recommend at least 15 days be provided. Therefore, the ADs are presently loaded at 16 percent of their hydraulic capacity. The volatile suspended solids (VSS) loading to the digesters was estimated to be 1,460 lb/day. Only one digester is in use at a time, so the volumetric VSS loading was 18 lb/1,000 cubic foot per day ($ft^3$-d). The WAC Chapter NR 110 allows loadings as high as 80 lb/1,000 $ft^3$-d. Therefore, the ADs are presently at only 12 percent of their VSS loading capacity.

In the anaerobic digesters, a portion of the VSS (typically around 50 to 60 percent) is destroyed. Following digestion, the liquid biosolids are pumped to the sludge storage tank for supernatant withdrawal and storage prior to land application. Table 2.02-1 summarizes the quantities of biosolids that were land-applied by WWTP staff from 2004 to 2007. Between 2004 and 2007, an average of 1.2 million gallons of digested biosolids were hauled to farmlands, or 3,300 gpd.

| Year | Biosolids Land-Applied (gal) |
|---|---|
| 2004 | 1,114,100 |
| 2005 | 1,043,990 |
| 2006 | 1,400,850 |
| 2007 | 1,221,400 |
| **Average** | **1,195,090** |

**Table 2.02-1 Annual Biosolids Disposal**

Table 2.02-2 compares the Whitewater biosolids metals concentrations in samples from 2004 to 2007 with regulatory values for land application as listed in WAC Chapter NR 204. Based on this data, the biosolids from the Whitewater WWTP meet all high quality metals requirements for land application.

## TABLE 2.01-2

## CONDITION OF EXISTING AD FACILITIES

| Unit Process or Equipment | Observations | Recommendations |
|---|---|---|
| Primary digesters | Covers were installed in 1982 and appear sound. Perth gas mixing system is inoperable. | Sandblast and repaint covers (2010). Provide new mixing system for digesters (for Digester No. 1 in 2010) |
| Sludge storage tank (Former Secondary Digester) | Cover was installed in 1982 and appears to be in good condition. Submersible mixing was added more recently and is inadequate. Access is poor. | Provide new mixing system and cover (2010). Provide better access to mixing system. |
| Supernatant pump | The supernatant pump is difficult to raise and lower. Supernatant flow is not metered and the supernatant is not sampled prior to discharge to the plant sewer. | Replace the supernatant pump and add a lifting system; provide a flow metering box where samples can also be collected (2010). |
| Primary digester recirculation pumps | Only the Digester No. 1 pump is in service, and this pump was rebuilt in the 1990s. The Digester No. 2 pump has been rebuilt and a new motor is available but not installed. | Replace the recirculation pump for Digester No. 1 (2010). Reassemble/install the existing recirculation pump for Digester No. 2 (2010). |
| Heat exchangers | The three heat exchangers were installed in 1982. Only the heat exchanger serving Digester No. 1 is in service. Heat exchangers No. 2 and No. 3 are not connected to the digester sludge piping. Heat exchangers appear to be in good condition. | Connect heat exchanger No. 2 to Digester No. 2 to maintain ability to heat both primary digesters. Provide a cross-connection so that either heat exchanger (No. 1 or No. 2) can be used for either digester (No. 1 or No. 2). (May be done in 2010.) |
| Sludge Transfer Pumps | Four duplex plunger pumps were installed in 1982 and have relatively low total hours of operation. Pumps appear to be in good condition. | Maintain existing pumps; consider replacement of components that are showing wear. (One pump will be removed in 2010 to provide space for mixing pumps.) |
| Sludge Loading Pump | Flygt pump manually cooled by water from nearby hose. Adequately loads sludge trucks. | Consider continued use of existing pump; add cooling jacket if possible or if desired. |
| Waste Gas Purifiers | Equipment appears nonfunctional. | Remove (2010). |
| Displacement Gas Holder | Equipment appears nonfunctional. | Remove (2010). |
| Digester biogas compressor | Compressor is nonfunctional and beyond repair according to WWTP staff. | Remove existing compressor (2010). If gas compression is part of the recommended alternative, replace compressor. |
| Digester biogas piping | Exposed piping appears to be in fair condition. | Prepare surface and repaint piping. Replace piping where necessary (Most in 2010). |
| Digester biogas safety equipment (drip traps, flame arresters, and accumulators) | Equipment appears nonfunctional. | Replace equipment (2010). |

| | | |
|---|---|---|
| Digester biogas sphere | Sphere has not been used for several years. Corrosion is evident on outside of sphere. | If high pressure gas storage is part of the recommended alternative, commission manufacturer to inspect sphere to determine if sandblasting and painting are feasible. Otherwise, consider biogas holding capacity in digester covers or install a new external biogas storage structure. |
| Waste Gas Burner | Code-required automatic ignition system is inoperable. Corrosion is evident on outside of flare. | Replace waste gas burner (2010). |
| Control Building and Pipe Tunnel | Exterior doors are in failing condition or nonoperational. | Replace exterior doors. National Fire Protection Association (NFPA) code classifications should be verified; ventilation should be at least six air changes per hour or gas handling equipment in the basement should be isolated from the MCCs and rated Class 1 Division 2 (explosion-proof). Pipe tunnel ventilation should likewise be at least six air changes per hour. Gas handling equipment should be isolated or space rated. |
| MCC | MCC is in the same room as the recirculation pumps and other equipment. | If required by code or because of other work in the building, enclose the MCC in a separate room and provide appropriate heating, ventilation, and air conditioning (HVAC). |

| Parameter | Units | 2004[1] | 2005[1] | 2006[1] | 2007[1] | High Quality Limit[2] | Ceiling Limit[3] | Class B Limit[5] |
|---|---|---|---|---|---|---|---|---|
| Arsenic | mg/kg | 28 | < 27 | < 21 | < 35 | 41 | 75 | – |
| Cadmium | mg/kg | 2.8 | 4.9 | 4.2 | 4.5 | 39 | 85 | – |
| Copper | mg/kg | 620 | 680 | 580 | 490 | 1500 | 4,300 | – |
| Lead | mg/kg | 25 | 37 | 30 | 29 | 300 | 840 | – |
| Mercury | mg/kg | 1.3 | 1.2 | 3 | 2.5 | 17 | 57 | – |
| Molybdenum | mg/kg | 28 | 27 | 20 | 22 | NA | 75 | – |
| Nickel | mg/kg | 19 | 28 | 17 | 18 | 420 | 420 | – |
| Selenium | mg/kg | 28 | < 49 | < 38 | <64 | 100 | 100 | – |
| Zinc | mg/kg | 970 | 930 | 920 | 860 | 2800 | 7500 | – |
| Fecal Coliforms[4] | cfu/gTS | 72,434 | 233,497 | 135,409 | 92,241 | NA | NA | 2,000,000 |

[1] Data taken from Compliance Maintenance Annual Reports from 2004 to 2007.
[2] High quality maximum values for land application according to Chapter NR 204, Table 3.
[3] Maximum values for land application according to Chapter NR 204, Table 1.
[4] Geometric mean of seven fecal coliform samples taken per year.
[5] From NR 204.

**Table 2.02-2 Biosolids Quality**

The annual geometric mean of fecal coliform densities measured in the sludge from 2004 to 2007 was in the range of 72,000 to 230,000 colony forming units per gram of total solids (cfu/gTS). These are below the Chapter NR 204 limit of 2,000,000 cfu/gTS for a Class B sludge.

## 2.03 CURRENT BIOGAS PRODUCTION AND QUALITY

| Component | Value |
|---|---|
| Methane ($CH_4$) | 60 to 65 percent |
| Carbon dioxide ($CO_2$) | 35 to 40 percent |
| Hydrogen sulfide ($H_2S$) | Variable; 300 to 3,000 ppmV[1] |
| Siloxanes | Variable; 300 to 3,500 ppbV[1] |
| Relative Humidity | 100 percent |
| Energy Content | 600 BTU/ft$^3$ |

[1]Based on biogas data compiled by Strand Associates from five Wisconsin and Illinois WWTPs

**Table 2.03-1 Typical Biogas Quality**

According to 2007 plant data, digested sludge hauled to farmland had a total solids concentration of 4.4 percent, with approximately 45 percent VSS content. The VSS reduction through the digester was calculated from the percent VSS of the digester feed sludge (72 percent) and the digested sludge hauled to farmland (45 percent). This data indicates a VSS reduction of about 70 percent through the primary digester and in the supernatant. This reduction is higher than typical because of the long retention time and low VSS loadings. There was approximately 1,000 lbs VSS destroyed per day in the digesters or removed in the supernatant. Total gas production is usually quantified from the amount of VSS destroyed. Typical values range from 12 to 18 ft$^3$/lb of VSS destroyed. According to 2008 meter readings, gas production in 2008 ranged from 7,800 to 19,000 ft$^3$/d, which corresponds to a gas production rate of 8 to 19 ft$^3$/lb VSS destroyed.

Presently, all biogas produced during anaerobic digestion is flared. Flaring converts the methane to carbon dioxide prior to release to the atmosphere.

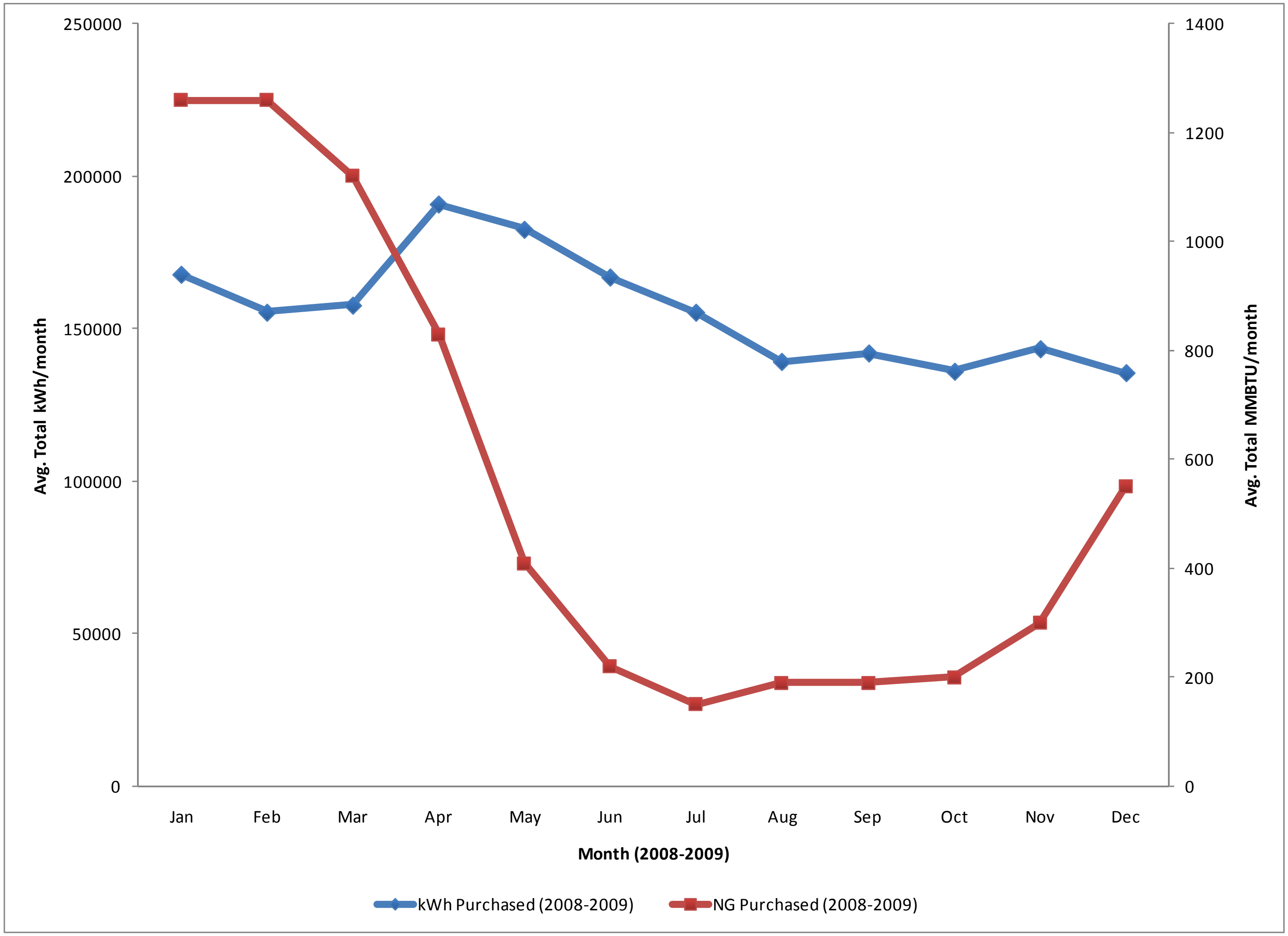
The quality of the biogas has not been determined through testing. Typical composition is shown in Table 2.03-1.

## 2.04 CURRENT ENERGY USE

Figure 2.04-1 shows the 2008 and 2009 plant electricity and natural gas energy use. Monthly electrical use ranged from 132,600 to 206,600 kwh with an average monthly use of 156,100 kwh. Monthly natural gas usage ranged from 115 to 1,357 MMBTU with an average monthly use of 557 MMBTU.

## FIGURE 2.04-1

## MONTHLY PLANT ENERGY USE



# SECTION 3
# EVALUATION OF ALTERNATIVES

## 3.01 PROJECTED FUTURE BIOSOLIDS PRODUCTION AND MANAGEMENT

A. Future Relevant Regulations

1. Biosolids Disposal and Beneficial Reuse

Biosolids disposal at the Whitewater WWTP follows the requirements of WAC Chapter NR 204, Domestic Sewage Sludge Management, and the requirements of Whitewater's Wisconsin Pollutant Discharge Elimination System (WPDES) permit. The biosolids data from 2004 through 2007 show low metal content and satisfy one of the requirements for "high quality" sludge. The Whitewater WWTP generates Class B biosolids based on the fecal coliform level in the solids being land spread.

Class B biosolids by definition have a higher level of pathogenic bacteria than Class A biosolids. Local farmers have readily accepted the Class B sludge for disposal on agricultural land. The majority of WWTPs in Wisconsin produce Class B sludge.

Producing Class A sludge would provide the following advantages over Class B sludge.

a. The sludge would contain a lower level of pathogenic bacteria. Class A biosolids must have a fecal coliform concentration of less than 1,000 most probable number (MPN) per gram total solids.

b. Land application site evaluation reports would not be required and bulk sludge land application reports would not need to be filed with the Wisconsin Department of Natural Resources (WDNR).

c. Whitewater would not need to receive approval from the WDNR prior to applying sludge.

d. More sites would potentially be available to apply the sludge.

e. Since Class A biosolids have lower levels of pathogens, there is a lower threat to human health, and therefore, fewer measures are required to minimize human contact with the sludge.

To be considered "exceptional quality sludge" or Class A, the biosolids must receive prescribed treatment to reduce pathogens and vector attraction. The prescribed treatment options available include lime stabilization, composting, heat drying, thermophilic aerobic digestion, temperature phased anaerobic digestion, heat treatment, pasteurization, or an equivalent process to further reduce pathogens.

Based on the current acceptance of Class B biosolids for beneficial reuse and the significantly increased capital and operating costs necessary to comply with Class A biosolids regulations, it is assumed the Whitewater WWTP will continue to use the current methods of biosolids stabilization and disposal.

2. Total Maximum Daily Load (TMDL) and Nutrients Impact

The United States Environmental Protection Agency (USEPA) and WDNR have begun TMDL development efforts for the Rock River Basin. The TMDL will focus on phosphorus and sediment. The City of Whitewater has joined a group of concerned municipalities called the Rock River TMDL Group (Group). The Group has been involved in the TMDL Technical Advisory Team and other efforts to guide the process, with the goal of producing a scientifically sound and fiscally responsible TMDL. As a member of the Group, Whitewater is informed of potential impacts of the TMDL on its stormwater and wastewater management programs. Currently the USEPA and WDNR plan to release a draft version of the Rock River TMDL report in 2010, with a final report (including any public comments and responses) due to the USEPA by September 2010. The TMDL could impact the quantity or methods of biosolids application onto farmland by requiring the agricultural community to place more emphasis on proper nutrient management. For example, if farmers are required to limit the amount of phosphorus applied to their fields, they may choose to land-apply manure generated on their farm before accepting biosolids.

The WDNR is in the process of developing nutrient water quality criteria. These regulations will likely result in lower effluent phosphorus limits at the Whitewater WWTP. Based on the current draft rules and depending on the amount of dilution from Whitewater Creek the WDNR uses to calculate the effluent limitations, it appears Whitewater's effluent total phosphorus limit could be as low as 0.1 to 0.2 mg/L. Removal to these levels will likely require an increased use of alum or other chemical. This will increase the total mass of sludge produced at the WWTP and will also increase the phosphorus content of the biosolids. It may be possible to mitigate the amount of chemical required by converting the WWTP to a treatment process that incorporates biological phosphorus removal.

The WDNR is also considering changes to biosolids regulations that could limit the rate of biosolids application to the phosphorus needs of the crop. Currently biosolids land application is typically limited to the nitrogen needs of the crop, and this is less restrictive.

Any of these developments could make it more difficult to find nearby sites that will accept all of Whitewater's biosolids. It is possible that additional land application sites will need to be permitted and that hauling distances will increase.

3. Emerging National Issues

According to the Water Environment Federation (WEF) Government Affairs Committee, three of the main issues emerging at the national level are sustainability, financing, and microconstituents.

The WEF is supporting sustainability measures including energy conservation measures. In Wisconsin, funding is available from Focus on Energy and some power and gas companies for studying and implementing energy conservation measures. This funding could be available to Whitewater for projects that increase energy efficiency (e.g., lighting, insulation, replacement of low-efficiency motors or equipment, automation and optimization of systems) or projects that more fully utilize digester biogas.

Approximately $10 billion in funding for wastewater projects was included in the economic stimulus legislation adopted by the House and Senate in 2009. The funding was routed through the existing state revolving fund programs including the Wisconsin Clean Water Fund. Funds were directed to projects that were ready to bid soon after the legislation was passed. Whitewater has participated in this program for its 2010 equipment replacement and rehabilitation project. It appears additional similar funding will be available in 2010. Additional funding may be available in future years.

Microconstituents are also known as “compounds of emerging concern.” They include pharmaceuticals, personal care products, and other compounds that are presently not specifically regulated in wastewater. The WDNR currently has the ability to regulate microconstituents from WWTPs only if a specific problem such as a directly linked adverse impact on aquatic life is demonstrated. Eventually, advanced oxidation processes or membrane treatment may be required to treat microconstituents. Some of these processes will make the microconstituents more concentrated in biosolids. Eventually, new regulations on microconstituents could change the way biosolids are managed.

4. Impact of Future Regulations on the Whitewater WWTP Biosolids Management Facilities

As indicated, the regulations summarized above may affect the Whitewater WWTP biosolids management in the future. They should be considered by providing sufficient budget for increased biosolids production, longer haul distances, additional labor, and similar foreseeable changes.

Should public perception or new regulations limit the ability of Whitewater to land-apply Class B sludge, consideration could be given to installing a Class A process at the WWTP or landfilling the biosolids. A Class A anaerobic digestion process could produce additional biogas. Landfilling of biosolids would not result in beneficial reuse of this resource. It is not expected that Class B biosolids restrictions will occur in the foreseeable future, so Class A processes will not be considered in this report.

## B. Population, Flow, and Loading Projections

The population of Whitewater and enrollment at UW-Whitewater are expected to increase in the future. Growth projections have been made by the City of Whitewater and are presented in the *Wastewater Treatment Plant Facilities Plan*, in preparation (draft) by Strand Associates, Inc.® A design year of 2030 was selected for the Facilities Plan, representing a typical planning period recommended by the WDNR for state-funded projects. The 2030 design year will also be used for this study. A summary of 2030 projected populations and relevant influent wastewater flows and loadings is given in Table 3.01-1.

| Parameter | 2030 Design |
|---|---|
| Projected Population | 17,566 |
| Annual Average Flow, mgd | 2.12 |
| BOD load, lb/day | 3,050 |
| TSS load, lb/day | 3,580 |
| TKN load, lb/day | 701 |

Note: Design flows and loads include 5 percent unplanned industrial growth allowance.

**Table 3.03-1 Design Population, Flows, and Loadings**

## C. Projected Biosolids Production

Influent flows and loadings are projected to increase through the year 2030 as indicated in Table 3.03-1. If wastewater treatment processes are not changed significantly, it is anticipated the loading to the digesters will increase approximately in proportion to the increased influent BOD load.

Therefore, the projected PRS and SSL pumped to the anaerobic digesters would be about 9,000 gallons per day (gpd). With one digester in use, this results in a primary digester retention time of 65 days, or 23 percent of Digester No. 1's 15-day hydraulic retention time capacity. The total solids and VSS loadings to the digesters are projected to increase to approximately 2,900 and 2,100 lb/day, respectively. With one digester in use, the volumetric VSS loading would be 27 lb/1,000 $ft^3$-d, or 34 percent of Digester No. 1 capacity. Therefore, Digester No. 1 will have more than adequate capacity and it should not be necessary to operate Digester No. 2 based on future biosolids production rates.

The increase in total sludge production from current levels (presented in Section 2) will depend on the alternative selected for biological treatment and whether biological or chemical phosphorus removal (CPR), or a combination of the two, is employed. For example, conventional activated sludge systems tend to produce more biological solids as compared to RBC systems. CPR produces a higher mass of total, but not necessarily volatile, solids. CPR may produce a higher volume of sludge, although this may be at least partially offset by the higher sludge solids concentrations that are often achieved with CPR. Biological phosphorus removal (BPR) also tends to produce a better settling and thickening sludge, so the slightly higher BPR sludge yield reported in some of the literature is not often observed in practice. For planning purposes, it is assumed Whitewater will need approximately 40 to 45 percent of Digester No. 1 capacity for 2030 biosolids digestion, and the remaining 55 to 60 percent is available for other purposes such as acceptance of other wastes or additional biosolids storage. Counting Digester No. 2, it is assumed Whitewater will need approximately 20 to 25 percent of its total AD capacity by 2030.

Whitewater presently uses only about 50 percent of its sludge storage tank capacity. Based on 2030 conditions and assuming Whitewater continues to aggressively supernate from the sludge storage tank to reduce digested sludge volume, Whitewater will have about 300,000 gallons, or about 25 percent, spare capacity in its sludge storage tank by 2030. Digester No. 2 will also be available for sludge storage if it is not used for other purposes.

Regardless of the treatment method employed, the quality of biosolids in terms of WAC Chapter NR 204 parameters is not expected to change significantly unless there is a change in the contribution from industrial dischargers. Current biosolids quality was presented in Section 2.

## C. Projected Biogas Production

The projected year 2030 biogas production assumes 16 $ft^3$/lb VSS destroyed. This is within the range of gas production measured at the plant for 2008 and appears reasonable based on the low digester loading rates and the installation of the new Digester No. 1 mixing system in 2010. Based on previously stated assumptions, approximately 1,700 lbs VSS are projected to be destroyed in Digester No. 1 in 2030, producing approximately 27,000 $ft^3$/d of biogas. At 600 BTU/$ft^3$ typical energy content, this represents 0.68 MMBTU an hour, 16 MMBTU a day, and 6,000 MMBTU a year.

## 3.02 POTENTIAL FUTURE SEPTAGE LOADINGS

The City currently accepts approximately 0.5 million gallons of septage at its raw influent receiving station every year. The acceptance of septage has resulted in objectionable odors in the Administration Building because of the location of the septage receiving station in relation to an air intake fan. Septage is strong [approximately 5,000 milligrams per liter (mg/L) BOD], and it is typically recommended that it be held and metered slowly into the influent rather than discharged in a short period of time. As part of its overall facility planning, the City is investigating moving the septage receiving station to a more remote location and adding a holding tank. This study also looks at taking septage directly to the anaerobic digesters. It appears there is currently enough capacity for about 1.8 million gallons per year of septage in Digester No. 1 and the sludge storage tank. By 2030, this would need to be reduced to about 0.6 million gallons unless Primary Digester No. 2 is placed in service for digestion and/or storage.

## 3.03 POTENTIAL FUTURE INDUSTRIAL WASTE LOADINGS

The City of Whitewater has been talking with nearby industries about potentially accepting some of their waste. One industry has several waste streams, including a high strength liquid and some solid waste. Handling the solid waste at the WWTP could be labor-intensive and problematic. The most likely method of conveying the material would be to grind it and add nonpotable water to create a slurry that could be pumped into the digester. If there are plastic wrappings or other nondigestible materials in the wastes, they may interfere with operation of downstream pumps and reduce the aesthetics of the biosolids for land application. There also may be fats, oils, and greases in the solid waste that would tend to accumulate at the top of the digester and make operations more difficult. At this time, we recommend only liquid wastes from the this industry be considered for AD in Digester No. 1 unless very consistent in quantity and quality sources of amenable solid wastes can be found. Another industry has approximately 10,000 gpd of a 35,000 mg/L BOD acetic acid waste that may be amenable for digestion. Liquid wastes from this industry could be considered for digestion at the WWTP.

Based on a 15-day design retention time, it appears there is enough spare capacity in Digester No. 1 to accept approximately 30,000 gpd of liquid waste currently and approximately 20,000 gpd by 2030. Assuming a high biomethane potential (BMP) for the waste of 395 ml $CH_4$ per gram of chemical oxygen demand, it appears the existing biogas handling system would be capable of handling a waste with a chemical oxygen demand (COD) in the neighborhood of 50,000 mg/L. Based on spare sludge storage tank capacity, typical sludge yields for AD, and continued aggressive supernating, the WWTP could accept approximately 5,000 lb/day additional COD load to Digester No. 1 now and about 2,000 lb/day additional COD load by 2030. If Digester No. 2 is used for sludge storage volume in the future, the lb/day of COD accepted would not need to decrease by 2030.

It is important to note that the evaluation of the AD capacity to accept liquid industrial waste presented above is very preliminary. The proposed liquid waste should be bench-tested for BMP and for potential toxicity, at a minimum, before any is accepted in the AD system. Because of the slow growth rate of the microbes and other reasons, anaerobic systems are more prone to upset by toxic compounds than aerobic systems. Therefore, it will be very important to perform initial bench-testing, perform full-scale pilot testing, and monitor the waste composition on a routine basis if the decision is made to accept industrial wastes in the Whitewater AD system.

### 3.04 POTENTIAL FUTURE MANURE LOADINGS

Manure is regulated differently than municipal biosolids. The regulations governing manure handling can be fairly complex particularly if the manure is generated at a WPDES-permitted concentrated animal feeding operation (CAFO). Permitted CAFOs are farms that usually have 1,000 or more animal units (AU). One of the more unique aspects of CAFO WPDES permitting is that CAFOs are not allowed to have a direct discharge to a receiving stream. Therefore, if manure is accepted from a CAFO for AD at Whitewater, the WDNR will need to be consulted to determine if the resulting digested manure supernatant or filtrate can be treated at the WWTP. The WDNR was consulted about regulations such as these for our Dane County Community Manure Management Feasibility Study project, and the preliminary determination was that such treated waste streams could likely be discharged to a municipal system for further treatment.

Farms that are permitted CAFOs also have to develop and follow nutrient management plans. Essentially, they are required to limit nitrogen and phosphorus loadings to the agronomic needs of the crop grown on each field. In some parts of the state (such as portions of Dane and Green counties), this is becoming problematic because of the high phosphorus concentrations that are already in the soils. If phosphorus is becoming limiting at fields in the vicinity of Whitewater, it can be removed chemically following AD and prior to land application or other ultimate use of the digested manure. However, this CPR step adds significant cost.

Manure has other unique features. It may contain significant sand, which, if not removed prior to AD, can increase wear on pumps and other equipment used in the AD process and can accumulate in the digester. It has pathogens that must be reduced if the manure is to be distributed to locations other than the source farm. For reduction of these pathogens, a longer AD detention time is recommended (at least 25 days versus 15 days for municipal sludge).

Based on previous discussions, the WDNR seems inclined to work with farmers to find solutions to various permitting issues. The WDNR is interested in helping to develop sustainable solutions for manure energy recovery and manure management.

Based on the information presented above, and on the research and findings of our Dane County studies, this study assumes the following:

1. Manure will be digested separately from the WWTP biosolids in Digester No. 2 and will have a 28-day retention time.
2. Separate digested manure storage facilities will be provided rather than combining with digested biosolids.
3. Digested manure supernatant/filtrate will be treated at the WWTP.
4. Each AU produces 25 gallons of liquid manure that when digested produces 59 $ft^3$ of methane (91 $ft^3$ total biogas) and 59,000 BTU per day

The assumptions above result in a Digester No. 2 capacity of about 840 AU. Therefore, Digester No. 2 appears to have the capacity to accept some of the liquid manure from a CAFO farm or to accept liquid manure from several smaller farms. As noted above, the digested manure will be handled separately from biosolids, which will maintain adequate future capacity in the WWTP sludge storage tank.

Several nearby farms were contacted regarding their interest in potential manure digestion. Their responses are in Appendix A. Additional details about manure digestion are provided in future sections of this report.

## 3.05 PRELIMINARY LIST OF ALTERNATIVES

The following alternatives were given a preliminary review as part of this study.

1. Digestion Alternatives

   a. Municipal biosolids digestion only (status quo).
   b. Municipal biosolids digestion plus septage.
   c. Municipal biosolids digestion plus food waste.
   d. Municipal biosolids digestion plus high strength liquid industrial waste.
   e. Agricultural/industrial waste digestion in Primary Digester No. 2 and management of digested liquid.
   f. Agricultural/industrial waste digestion in Primary Digester No. 2, dewatering, and management of dewatered manure plus filtrate.

2. Biogas Utilization Alternatives

   a. Continue to flare biogas (status quo).

   b. Biogas utilization in existing on-site boiler (retrofit).
      (1) With gas conditioning.
      (2) Without gas conditioning.

   c. Biogas utilization in new on-site boiler.
      (1) With gas conditioning.
      (2) Without gas conditioning.

   d. Biogas utilization at Cogentrix-LS Power Plant
      (1) Without any steam/hot water purchase.
      (2) With steam or hot water purchase.

   e. Biogas utilization in existing on-site generators.

   f. Biogas utilization in new on-site microturbine(s).

   g. Biogas utilization in solids dryer.

   h. Biogas utilization in fuel cells.

Based upon review of relative costs and the status of the technologies, a few alternatives were eliminated from further consideration. First, it was assumed that gas conditioning (specifically hydrogen sulfide and siloxane removal) prior to use in an on-site boiler will not be required. This is based on our experience at similar facilities and the fact that Hawthorn-Melody, which was a historical source of sulfur in the wastewater, is now closed. Prior to any final design, the biogas should be tested to assure that siloxane and hydrogen sulfide levels are low enough for use in a boiler.

Biogas utilization at Cogentrix with steam or hot water purchase was briefly considered. Cogentrix does not currently have enough spare capacity to provide hot water at the temperature required by WWTP heating equipment. Additional facilities would need to be constructed at Cogentrix to produce the additional hot water. If steam was purchased from Cogentrix, a steam-to-water heat exchanger would be required at the WWTP to make the energy usable in existing WWTP heating equipment. A stream pipeline and condensate return line would need to be constructed from Cogentrix to the WWTP. The capital cost for this alternative would be approximately $1.5 million and the total present worth about $2.2 million. Cogentrix's costs would need to be added to this. With this alternative, biogas would continue to be flared. This alternative was eliminated from further consideration for cost and other reasons.

Biogas utilization in a solids dryer was eliminated from further consideration because it appeared the high capital cost of this alternative (in excess of $6 million based on preliminary quotes from sludge drying equipment suppliers) would not be offset by savings in sludge trucking and land application costs. Futhermore, it does not appear that grants would be as readily available for this alternative as they might be for other alternatives.

Biogas utilization in fuel cells was eliminated from further consideration because of the high cost and very new state of the technology. At this time, this technology appears best suited for WWTPs or other facilities that produce biogas at a significantly higher rate than Whitewater and that have more stringent air quality permitting requirements.

## 3.06 EVALUATION OF SHORT-LISTED ALTERNATIVES

### A. Summary of Alternatives

From the preliminary list of alternatives, a short list of alternatives was evaluated with respect to capital and operational costs. These are listed in Table 3.06-1.

### B. Potential Energy Production of Selected Alternatives

The natural gas savings and electric energy production were predicted for several alternatives. Figure 3.06-1 shows the predicted electric output using microturbines (BG6) for four digestion alternatives compared to the current electricity use. At least three microturbines would be needed to provide a significant amount of the WWTP's electricity needs, and even operating both digesters at full capacity, the current electrical needs still exceed the predicted electricity production during the highest use month of the year. Figure 3.06-2 shows the predicted heat output for four digestion scenarios compared to the current natural gas usage. Alternative DG2-B meets or exceeds the heating needs in all but the three coldest months assuming sufficient industrial liquid waste can be obtained to bring Digester No. 1 to full capacity. Approximately 84 percent of the WWTP's heating needs could be met using this alternative. The remaining biogas would be flared. Under current conditions less than 50 percent of the heating needs could be met through biogas.

### C. Probable Cost of Alternatives

The opinion of capital and long-term cost for each short-listed alternative was developed. The costs are presented in Appendix B, and a summary is presented in Table 3.06-2. Section 4 provides more detailed information about the recommended combination of alternatives.

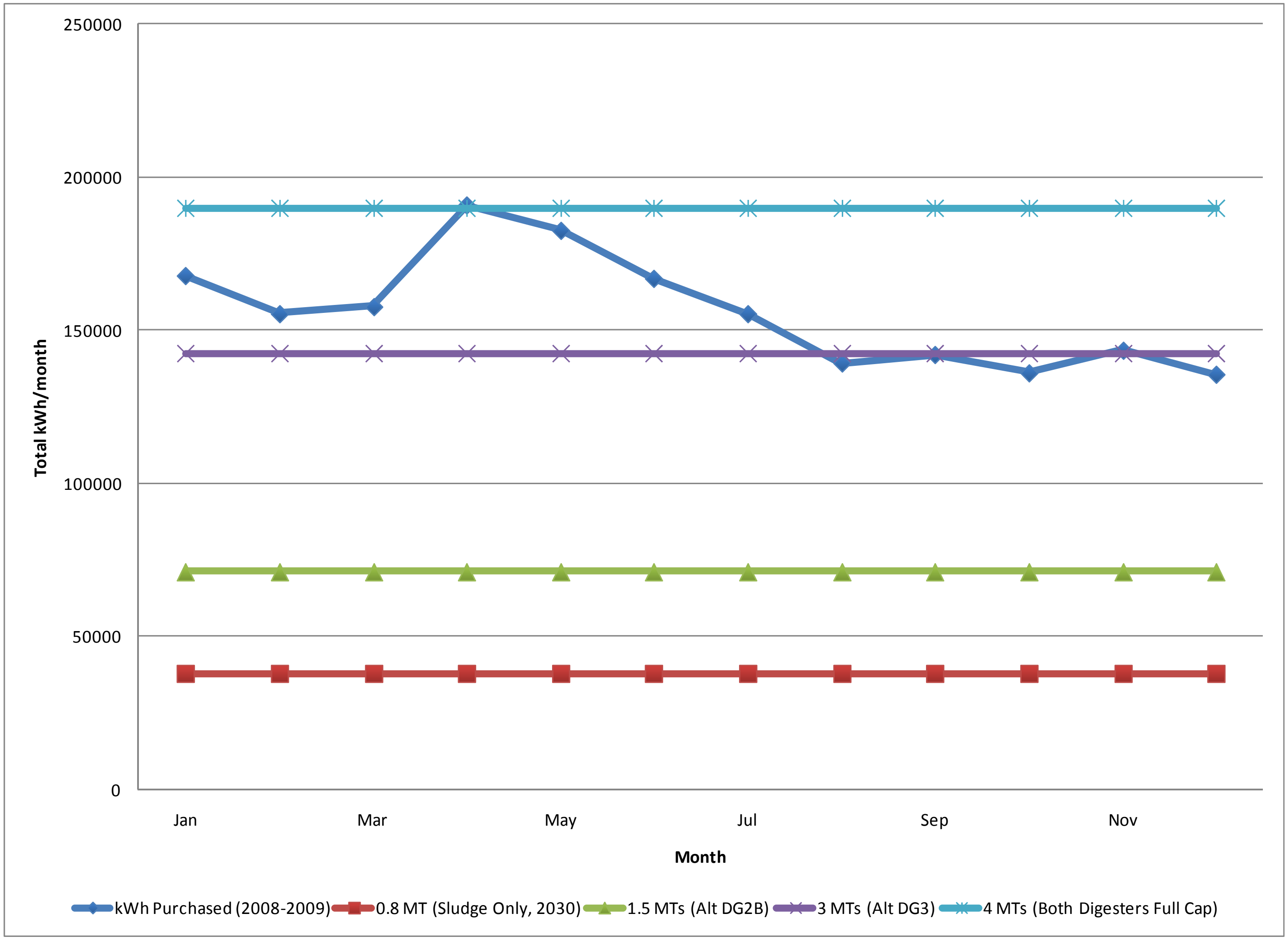
## TABLE 3.06-1

## ALTERNATIVES LIST

| | Alternative | Description |
|---|---|---|
| DG1 | Municipal Biosolids Digestion Only (Status Quo) | Replace gas handling and safety equipment; add primary digester mixing and recirculation for one digester; replace secondary digester (sludge storage tank) cover and install recirculation pump; confirm capacity for 2030 conditions. (Done in 2010, Contract 4-2009) |
| DG2-A | Municipal Biosolids Digestion plus Septage and possibly food waste | Same as above but with new septage receiving station with screening. |
| DG2-B | Municipal Biosolids Digestion plus High Strength Liquid Industrial Waste | Same as above but no need for screening at receiving station. |
| DG3 | Agricultural/Industrial Waste Digestion in Primary Digester No. 2–Liquid | Same as DG1 but for both primary digesters. Also add short (~10 day) storage tank on front end, and separate 180-day storage. |
| DG4 | Agricultural/Industrial Waste Digestion in Primary Digester No. 2–Dewatered | Same as DG3 but add conditioning, dewatering, and separate 45d storage of dewatered manure. |
| | | |
| BG1 | Continue to Flare Biogas (Status Quo) | Flare costs are included in Contract 4-2009. (Done in 2010) |
| BG2 | Biogas Utilization in Existing On-Site Boiler (Retrofit) | Assume new compressor; new burner at boiler along with pressure regulators and gas blending; gas piping. |
| BG3 | Biogas Utilization in New On-Site Biogas Boiler | New boiler (combination heater/heat exchanger) and gas piping. |
| BG4 | Biogas Utilization at Cogentrix | Gas conditioning equipment; new compressor; rehabilitation of gas sphere; and pipeline. |
| BG5 | Biogas Utilization in Existing On-Site Generators | Gas conditioning equipment; compressor; new biogas storage; and piping. |
| BG6 | Biogas Utilization in New On-Site Microturbine(s) | Gas conditioning equipment; compressor; new biogas storage; and piping. |

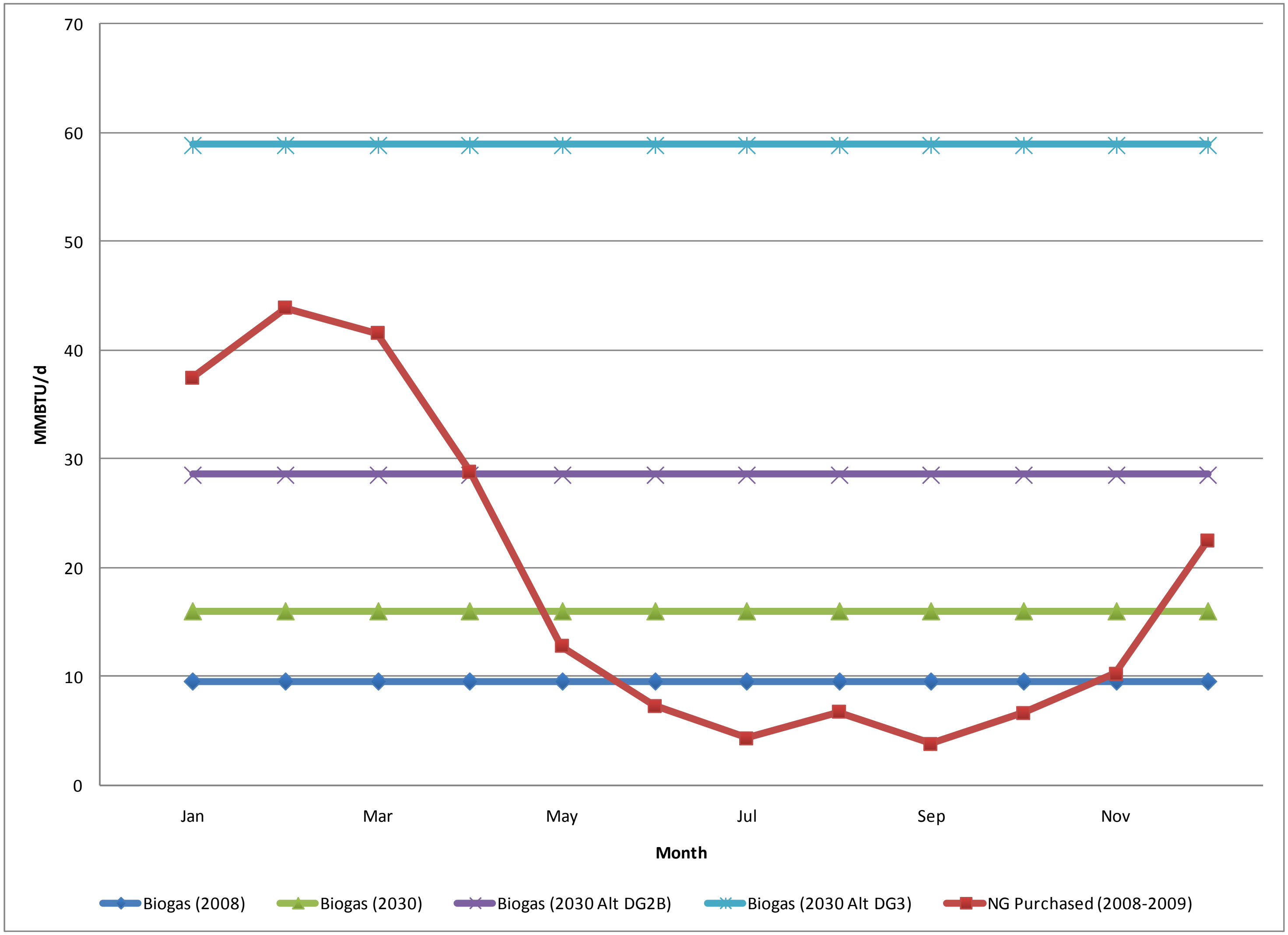
## FIGURE 3.06-1

## PREDICTED ELECTRICITY PRODUCTION



## FIGURE 3.06-2

## PREDICTED BIOGAS PRODUCTION



## TABLE 3.06-2

## SUMMARY OF PROBABLE COSTS FOR SHORT-LISTED ALTERNATIVES

| Alternative No. | Description | Capital Cost | PW of O,M,R, and S | Total PW | Amoritized PW |
|---|---|---|---|---|---|
| DG1 | Municipal Biosolids Digestion Only (Status Quo) | $0 | $2,685,000 | $2,685,000 | $204,000 |
| DG2-A | Municipal Biosolids Digestion plus Septage and possibly food waste | 493,000 | 3,462,000 | 3,955,000 | 301,000 |
| DG2-B | Municipal Biosolids Digestion plus High Strength Liquid Industrial Waste | 332,000 | 3,595,000 | 3,927,000 | 299,000 |
| DG3 | Agricultural/Industrial Waste Digestion in Primary Digester No. 2 - Liquid | 1,933,000 | 4,700,000 | 6,633,000 | 504,000 |
| DG4 | Agricultural/Industrial Waste Digestion in Primary Digester No. 2 - Dewatered | 3,872,000 | 4,558,000 | 8,430,000 | 641,000 |
| | | | | | |
| BG1 | Continue to Flare Biogas (Status Quo) | 0 | 39,000 | 39,000 | 3,000 |
| BG2 | Biogas Utilization in Existing On-Site Boiler (Retrofit) | 612,000 | 70,000 | 682,000 | 52,000 |
| BG3 | Biogas Utilization in New On-Site Biogas Boiler | 643,000 | 11,000 | 654,000 | 50,000 |
| BG4 | Biogas Utilization at Cogentrix | 1,365,000 | 862,000 | 2,227,000 | 169,000 |
| BG5 | Biogas Utilization in Existing On-Site Generators | 1,875,000 | 559,000 | 2,434,000 | 185,000 |
| BG6 | Biogas Utilization in New On-Site Microturbine(s) | 1,770,000 | 1,004,000 | 2,774,000 | 211,000 |

Notes: All costs are Fourth Quarter 2009 Dollars.
PW = 20-year present worth at discount rate of 4.375%

# SECTION 4
# SUMMARY AND CONCLUSIONS

## 4.01 RECOMMENDED ALTERNATIVES

Section 3 presented a review and evaluation of alternatives for the anaerobic digestion system at the WWTP. Based on monetary and nonmonetary considerations, we recommend alternatives DG2-B Municipal Biosolids Digestion plus High Strength Liquid Industrial Waste and BG3-Biogas Utilization in New On-Site Biogas Boiler. This project recommendation is dependent upon a reliable source of treatable high-strength waste and associated revenue and other project funding as discussed below.

If feasible at the time the project is implemented, the hauled waste recycling facilities could be designed to accept septage. This will provide flexibility and potentially move septage receiving away from the Main Control Building where odors are a concern.

The proposed site plan for the recommended projects is shown in Figure 4.01-1.

## 4.02 PROJECT COSTS

The overall project capital costs for Alternatives DB2-B and BG3 are shown in Table 4.02-1, and the estimated annual operation and maintenance costs are presented in Table 4.02-2. The full cost evaluation is presented in Appendix C, and the total present worth is summarized in Table 4.02-3.

| Construction Item | Cost[a] |
|---|---|
| Equipment and Structures | |
| Offloading Station | $ 44,000 |
| Holding Tank | 54,000 |
| Submersible Pumps, Controls, Card Reader System | 42,000 |
| Biogas Boiler | 304,000 |
| **Subtotal Equipment and Structures** | **$444,000** |
| | |
| Electrical | 75,000 |
| Piping/Mechanical | 93,000 |
| HVAC | 22,000 |
| Site Work Including Driveway and Gate | 35,000 |
| **Subtotal Base Construction** | **$669,000** |
| | |
| Contractor General Conditions (8 percent) | 54,000 |
| **Opinion of Probable Construction Cost** | **$723,000** |
| | |
| Technical Services and Contingencies (35 percent) | 253,000 |
| **Opinion of Total Project Cost** | **$976,000** |

[a]Fourth quarter 2009 basis.

**Table 4.02-1 Opinion of Probable Cost for Recommended Project**

| | |
|---|---|
| Labor | $ 23,200 |
| Power | 13,000 |
| Maintenance and Supplies | 18,100 |
| Natural Gas Saving–after biogas utilization | (54,000) |
| Additional Sludge (gal/year) | 911,000 |
| Additional Sludge Handling and Disposal | 45,600 |
| Additional Supernatant (gal/year)* | $6,388,000 |
| Additional Supernatant Treatment at WWTP** | 83,000 |
| **Total** | **129,000** |
| Present Worth O&M | $1,696,000 |

***** Assumes 20,000 gpd waste is at 5,000 lb/day COD and 2,500 gpd sludge produced (remainder is supernatant).
**Supernatant treatment includes costs for additional power and phosphorus removal chemical.

**Table 4.02-2 Incremental Estimated Annual O&M Costs**

| | |
|---|---|
| Capital Cost | $ 976,000 |
| Replacement | 80,000 |
| O&M Cost | $1,696,000 |
| Salvage Value | (64,000) |
| **Total Present Worth** | **$2,668,000** |
| | |
| Annualized PW | $ 204,000 |
| Revenue Required ($/1000 gallons waste accepted) | $ 28 |

**Table 4.02-3 Summary of Present Worth Costs for Recommended Project**

## 4.03 PROJECT FUNDING

The project may be funded through user charges, loans, or possibly grants or carbon credits. Loans would be through the Wisconsin Clean Water Fund (CWF) or local sources. An Intent to Apply (ITA) and a Priority Evaluation and Ranking Form (PERF) have already been submitted to the CWF program for this project. Projects are scored and loans are granted according to the priority score of each project.

If septage receiving facilities are constructed, that portion of the project may be eligible for a 0 percent CWF loan.

User charges would need to be increased enough to make loan payments. If the entire project were funded through a loan, $28 of additional revenue for each 1,000 gallons of industrial waste accepted would be needed assuming that approximately 20,000 gpd of waste were accepted. These costs would need to be appropriately distributed between the industrial haulers and the sewer users. To reduce user charges and capital costs funded through loans, the industry could pay for certain capital costs like the offloading station, holding tank, and accessories; or grants could be applied for.

Grants through Wisconsin Focus on Energy for energy saving projects are available. This project would reduce the WWTP natural gas consumption by 84 percent, and it would utilize approximately 54 percent of the biogas instead of flaring it. It appears a grant of about $50,000 would be available. Specific program requirements can be found on their website, www.focusonenergy.com. A grant may also be available through We Energies. This project would also reduce the WWTP's carbon footprint which would make it a candidate for selling carbon credits. In the recent past this would have been a viable option, but the current value of carbon is extremely low ($0.10 per metric ton $CO_2$ in March 30, 2010).

## 4.04 PROJECT SCHEDULE

The schedule for this project will be dependent on the availability of high strength liquid wastes and associated revenue and on the availability of other funding sources.

## 4.05 OTHER IMPLEMENTATION CONSIDERATIONS

As noted in Section 3, any proposed high strength liquid wastes should be carefully bench-tested and also tested full-scale before final acceptance. If favorable, it is recommended that a long-term contract be negotiated with the industry to assure the expected waste and revenue will be available to the City for a viable project.

# APPENDIX A
# FARM SURVEYS

1. Katzman Farms Inc.(Dairy)
   Contact: Tom Katzman
   W7889 Reliance Road
   Whitewater, WI 53190
   262-473-6287

2. Pond Hill Dairy LLC(Dairy)
   Contact: Keith Moritz
   W6770 Pond Road
   Fort Atkinson, WI 53538
   920-723-9751
   keithmoritz@pondhilldairy.com

3. Jerry & Jarrod Kollwelter(Dairy)
   W7522 Bluff Road
   Whitewater, WI 53190
   262-473-5158

4. Kutz Dairy LLC(Dairy)
   Contact: Ron Kutz
   N3612 Will Road
   Jefferson, WI 53549
   920-674-2319
   kutzdairy@gmail.com

5. Bob Wagner (Swine)
   N329 Myra Lane
   Whitewater, WI 53190
   262-473-4290

6. Ralph Giorno (Veal)
   W7596 Hwy 12
   Whitewater, WI 53190
   262-473-3780

G:/Projects/Facility Plan/Ag Contacts

# Whitewater Wastewater Treatment Plant Agricultural Questionnaire

City of Whitewater
312 W. Whitewater Street
P.O. Box 178
Whitewater, WI 53190
(262) 473-5920 (Phone)
(262) 473-5930 (Fax)
treel@ci.whitewater.wi.us (E-mail)

Please answer all of the questions to the best of your ability. Please be advised that the City of Whitewater will refuse to disclose the results of these surveys pursuant to any open records requests based on the public purpose of keeping the records confidential so as to maximize the opportunity to receive complete and accurate responses. Mail or fax your questionnaire by September 17, 2008, to the address or fax number listed above attn: Tim Reel.

Facility Name: RUSCH DAIRY Contact Person and Title: DENNIS RUSCH - PART
Facility Description Including Products: WE PRODUCE MILK - CULL COWS + SELL BULL CALVES HEIFER CALVES ARE CUSTOM RAISED
Road or PO Box Address: N 2165 CO HWY N
Town FORT ATKINSON ZIP 53538

Phone Number: 920-563-4118 E-mail Address: ______

CAFO WPDES Permit Number (if applicable): ______

How many head of livestock are you now raising on all of your farm sites? Plan for 2009? Plan for 2013?

| | Dairy Total | Dairy Milking Cows* | Dairy Dry Cows* | Dairy Other * | Total Beef | Total Swine | Total Poultry | Other (describe) |
|---|---|---|---|---|---|---|---|---|
| 2008 Current | 250 | 200 | 50 | | | | | |
| 2009 Next Year | 250 | 200 | 50 | | | | | |
| 2013 Five Years | | | | | | | | |

* This number should also be included in the total dairy herd.

How much livestock manure is generated each year on your farm? (Enter estimates for each type.)

______ gal/year ______ cubic yards/year 5000 - 6000 tons/year

Please describe your existing manure handling facilities. WE HAVE A 200 COW FREESTALL BARN WITH SAND BEDDING - IT IS CLEANED 2X DAILY INTO A GRAVITY PUSH OFF SLAB. WE ARE ON A DAILY HAUL ROUTINE

Are biocides or other chemicals used that end up in liquid manure? If so, approximately how much per month? (Please attach a copy of ingredients from package labeling or MSDS.)

JUST SAND

Do you plan to expand your facility in the future? If so, how many animal units would be added? Would your manure handling change?

NO PLANS AT THIS TIME

If the City accepted liquid manure in its anaerobic digester located at the WWTP (off CTH U near the Cogentrix Power Plant), would you be interested? Would you pay for this service?

I WOULD BE INTERESTED AT CERTAIN TIMES OF THE YEAR. I DEPENDS ON COST.

Are there any other wastes that you need an outlet for?

NO

Do you have any non-potable water needs such as for flushing, irrigation, etc., and would there be interest in accepting wastewater treatment plant effluent from the City? Would there be an interest in accepting fully digested liquid manure or biosolids from the City?

?

# Whitewater Wastewater Treatment Plant Agricultural Questionnaire

City of Whitewater
312 W. Whitewater Street
P.O. Box 178
Whitewater, WI 53190
(262) 473-5920 (Phone)
(262) 473-5930 (Fax)
treel@ci.whitewater.wi.us (E-mail)

Please answer all of the questions to the best of your ability. Please be advised that the City of Whitewater will refuse to disclose the results of these surveys pursuant to any open records requests based on the public purpose of keeping the records confidential so as to maximize the opportunity to receive complete and accurate responses. Mail or fax your questionnaire by September 17, 2008, to the address or fax number listed above attn: Tim Reel.

Facility Name: RALPH GIORNO Contact Person and Title: ____________
Facility Description Including Products: FARM – VEAL – Sheep

Road or PO Box Address: W7596 Hwy 12
Town WHITEWATER ZIP 53190

Phone Number: 262-473-6066 E-mail Address: ____________

CAFO WPDES Permit Number (if applicable): ____________

How many head of livestock are you now raising on all of your farm sites? Plan for 2009? Plan for 2013?

| | Dairy Total | Dairy Milking Cows* | Dairy Dry Cows* | VEAL Dairy Other * | Total Beef | Total Swine | Total Poultry | SHEEP Other (describe) |
|---|---|---|---|---|---|---|---|---|
| 2008 Current | | | | 320 | | | | 150 Hd |
| 2009 Next Year | | | | 320 | | | | 150 |
| 2013 Five Years | | | | 320 | | | | 200 |

* This number should also be included in the total dairy herd.

How much livestock manure is generated each year on your farm? (Enter estimates for each type.)

32000.00 gal/year ____________ cubic yards/year UNKNOWN ____________ tons/year

Please describe your existing manure handling facilities. HOLDING TANKS + LAGOON AND MANURE PILE FOR SPREADING

Are biocides or other chemicals used that end up in liquid manure? If so, approximately how much per month? (Please attach a copy of ingredients from package labeling or MSDS.)

CLORINE IN WASHING OF TANKS

Do you plan to expand your facility in the future? If so, how many animal units would be added? Would your manure handling change? NO

If the City accepted liquid manure in its anaerobic digester located at the WWTP (off CTH U near the Cogentrix Power Plant), would you be interested? Would you pay for this service?

YES, I WOULD ~~[illegible]~~ PAY DEPENDING ON THE COST

Are there any other wastes that you need an outlet for? NO

Do you have any non-potable water needs such as for flushing, irrigation, etc., and would there be interest in accepting wastewater treatment plant effluent from the City? Would there be an interest in accepting fully digested liquid manure or biosolids from the City?

yes.

## Tranowski, Glenn

---

**From:** Carlson, Jane
**Sent:** Thursday, October 09, 2008 7:30 AM
**To:** Tim Reel
**Cc:** Tranowski, Glenn
**Subject:** RE: ag follow up

Jane M. Carlson, P.E.
Strand Associates, Inc.
(608) 251-4843

---

**From:** Tim Reel [mailto:TReel@ci.whitewater.wi.us]
**Sent:** Wednesday, October 08, 2008 1:38 PM
**To:** Carlson, Jane
**Cc:** Dean Fischer
**Subject:** ag follow up

Jane, I made some phone calls and found two relatively interested parties.
They are:
Kutz Dairy
13-14 MG of manure / year
1200 head
They utilize sand bedding.
An issue was transportation costs.
They are planning on doing something w/separation in 3-4yrs.

Pond Hill Dairy
18,000 gallons of manure / day (containing 20-30 lbs. of bedding)
Sand bedding
700 head
Estimated separation costs for building, equipment etc. = $200,000
Limited interest as Keith was involved in the past w/Brad Tuttle and Daniel DeBuhr and nothing worked out?
Wanted to know where we wanted to be or expected to be in 5yrs. !

***Tim Reel***
City of Whitewater
Wastewater Superintendent
e-mail: treel@ci.whitewater.wi.us
P: 262-473-5920
F: 262-473-5930

# APPENDIX B
# OPINIONS OF COST FOR ALTERNATIVES

## City of Whitewater Digestion Study
### Alternative DG1
### Municipal Biosolids Digestion in Digester 1 (Status Quo)

Discount Rate 4.38%

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| Supernatant Pump and Meter - in 15 years | $0 | $7,500 | 15 | $4,000 | 15 | $5,000 | $2,000 |
| Subtotal | $0 | | | | | | |
| Piping/Mechanical (18%) | $0 | | | $0 | 30 | $0 | $0 |
| Electrical (15%) | $0 | | | $0 | 20 | $0 | $0 |
| HVAC (3%) | $0 | | | $0 | 20 | $0 | $0 |
| Sitework (5%) | $0 | | | $0 | 20 | $0 | $0 |
| Subtotal | $0 | | | | | | |
| Contractor's General Conditions (8%) | $0 | | | | | | |
| Total Construction Costs | $0 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $0 | | | | | | |
| Total Capital Costs | **$0** | $8,000 | | $4,000 | | $5,000 | $2,000 |
| Present Worth | $0 | | | $4,000 | | | $2,000 |

| ***Estimated Annual O&M Costs*** | |
|---|---|
| Labor | $109,000 |
| Power | $21,000 |
| Maintenance and Supplies | $10,000 |
| Natural Gas Purchase - entire plant | $64,000 |
| Total | $204,000 |
| Present Worth of O&M | $2,683,000 |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $0 |
| Replacement | $4,000 |
| O&M Cost | $2,683,000 |
| Salvage Value | ($2,000) |
| **TOTAL PRESENT WORTH** | **$2,685,000** |
| Annualized PW | $204,000 |

Notes:
All costs are fourth quarter 2009 dollars.
Present worth is calculated on a 20-year basis at discount rate shown.

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Natural Gas | $9.60 | per MMBTU |

## City of Whitewater Digestion Study
### Alternative DG2 - A
### Municipal Biosolids Digestion Plus Septage in Digester 1

Discount Rate 4.38%

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| Packaged Septage Receiving Station | $174,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Holding Tank | $20,000 | $0 | 30 | $0 | 10 | $0 | $0 |
| Submersible Pumps, Controls, Card Reader system | $42,000 | $38,889 | 15 | $20,000 | 15 | $28,000 | $12,000 |
| Supernatant Pump and Meter - in 15 years | $0 | $7,500 | 15 | $4,000 | 15 | $5,000 | $2,000 |
| Subtotal | $236,000 | | | | | | |
| Piping/Mechanical (18%) | $42,000 | | | $0 | 30 | $14,000 | $6,000 |
| Electrical (15%) | $35,000 | | | $0 | 20 | $0 | $0 |
| HVAC (0%) | $0 | | | $0 | 20 | $0 | $0 |
| Sitework Including Driveway and Gate | $25,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $338,000 | | | | | | |
| Contractor's General Conditions (8%) | $27,000 | | | | | | |
| Total Construction Costs | $365,000 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $128,000 | | | | | | |
| Total Capital Costs | **$493,000** | $46,000 | | $24,000 | | $47,000 | $20,000 |
| Present Worth | $493,000 | | | $24,000 | | | $20,000 |

| ***Estimated Annual O&M Costs*** | |
|---|---|
| Labor | $118,000 |
| Power | $21,000 |
| Maintenance and Supplies | $14,000 |
| Natural Gas Purchase - entire plant | $64,000 |
| Additional biogas (cf/yr) | 2,500,000 |
| Value of additional biogas, if gas is fully utilized | ($14,000) |
| Additional Sludge (gal/year) | 911,000 |
| Additional Sludge Handling and Disposal | $45,600 |
| Additional Supernatant (gal/year) | 1,090,000 |
| Additional Supernatant Treatment at WWTP** | $14,000 |
| Total | $263,000 |
| Present Worth of O&M | $3,458,000 |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $493,000 |
| Replacement | $24,000 |
| O&M Cost | $3,458,000 |
| Salvage Value | ($20,000) |
| **TOTAL PRESENT WORTH** | **$3,955,000** |

Annualized PW $301,000

$97,000 Approx. additional annual revenue required compared to status quo
$54 Revenue required ($/1000 gallons waste accepted)*

Notes:
All costs are fourth quarter 2009 dollars.
Present worth is calculated on a 20-year basis at discount rate shown.
Would need to reduce waste acceptance to 40% by 2030 or would need additional storage (Digester 2) for 2030*
*Assumes 1.8 MG of septage per year.
**Supernatant treatment includes costs for additional power and phosphorus removal chemical.

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Additional sludge handling and disposal | $0.05 | per gallon |
| Biogas value | $9.60 | per MMBTU |
| Supernatant treatment cost** | $0.013 | per gallon |

## City of Whitewater Digestion Study
### Alternative DG2 - B
### Municipal Biosolids Digestion Plus Industrial Waste in Digester 1

Discount Rate 4.38%

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| Offloading station | $44,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Holding Tank | $54,000 | $0 | 30 | $0 | 10 | $0 | $0 |
| Submersible Pumps, Controls, Card Reader system | $42,000 | $38,889 | 15 | $20,000 | 15 | $28,000 | $12,000 |
| Supernatant Pump and Meter - in 15 years | $0 | $7,500 | 15 | $4,000 | 15 | $5,000 | $2,000 |
| Subtotal | $140,000 | | | | | | |
| Piping/Mechanical (25%) | $35,000 | | | $0 | 30 | $12,000 | $5,000 |
| Electrical (20%) | $28,000 | | | $0 | 20 | $0 | $0 |
| HVAC (0%) | $0 | | | $0 | 20 | $0 | $0 |
| Sitework Including Driveway and Gate | $25,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $228,000 | | | | | | |
| Contractor's General Conditions (8%) | $18,000 | | | | | | |
| Total Construction Costs | $246,000 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $86,000 | | | | | | |
| Total Capital Costs | **$332,000** | $46,000 | | $24,000 | | $45,000 | $19,000 |
| Present Worth | $332,000 | | | $24,000 | | | $19,000 |

| ***Estimated Annual O&M Costs*** | |
|---|---|
| Labor | $114,000 |
| Power | $21,000 |
| Maintenance and Supplies | $12,000 |
| Natural Gas Purchase - entire plant | $64,000 |
| Additional biogas (cf/yr) | 11,563,000 |
| Value of additional biogas, if gas is fully utilized | ($67,000) |
| Additional Sludge (gal/year) | 911,000 |
| Additional Sludge Handling and Disposal | $45,550 |
| Additional Supernatant (gal/year)* | 6,388,000 |
| Additional Supernatant Treatment at WWTP** | $83,044 |
| Total | $273,000 |
| Present Worth of O&M | $3,590,000 |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $332,000 |
| Replacement | $24,000 |
| O&M Cost | $3,590,000 |
| Salvage Value | ($19,000) |
| **TOTAL PRESENT WORTH** | **$3,927,000** |

| | | | |
|---|---|---|---|
| Annualized PW | $299,000 | $95,000 | Approx. additional annual revenue required compared to status quo |
| | | $13 | Revenue required ($/1000 gallons waste accepted)* |

Notes:

All costs are fourth quarter 2009 dollars.

Present worth is calculated on a 20-year basis at discount rate shown.

Would need to reduce waste acceptance to 40% by 2030 or would need additional storage (Digester 2) for 2030*

*Assumes 20,000 gpd waste in at 5,000 lb/day COD and 2,500 gpd sludge produced (remainder is supernatant)

**Supernatant treatment includes costs for additional power and phosphorus removal chemical.

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Additional sludge handling and disposal | $0.05 | per gallon |
| Biogas value | $9.60 | per MMBTU |
| Supernatant treatment cost | $0.013 | per gallon |

## City of Whitewater Digestion Study

**Alternative DG3**

**Agricultural Waste Digestion in Primary Digester No. 2 with Mixing** Discount Rate 4.38%

*Liquid digested waste hauling*

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| Packaged Receiving Station | $174,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Ten Day Raw Storage | $176,000 | $0 | 30 | $0 | 10 | $0 | $0 |
| Submersible Pumps, Controls, Card Reader system | $42,000 | $19,000 | 15 | $10,000 | 15 | $28,000 | $12,000 |
| Primary Digester No. 2 Mixing Pumps | $103,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Primary Digester No. 2 Recirculation Pump | $34,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Liquid Digested Manure Storage (Lagoons - 180+days) | $370,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Liquid Pumping Station for Supernating and Hauling | $34,000 | $25,000 | 15 | $13,000 | 15 | $23,000 | $10,000 |
| Supernatant Pump and Meter - in 15 years | $0 | $7,500 | 15 | $4,000 | 15 | $5,000 | $2,000 |
| Subtotal | $933,000 | | | | | | |
| Piping/Mechanical (18%) | $168,000 | | | $0 | 30 | $56,000 | $24,000 |
| Electrical (15%) | $140,000 | | | $0 | 20 | $0 | $0 |
| HVAC (1%) | $9,000 | | | $0 | 20 | $0 | $0 |
| Sitework (5%) | $47,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $1,297,000 | | | | | | |
| Contractor's General Conditions (8%) | $104,000 | | | | | | |
| Total Construction Costs | $1,401,000 | | | | | | |
| Contingencies, Legal & Engineering Services (38%)* | $532,000 | | | | | | |
| Total Capital Costs | **$1,933,000** | $52,000 | | $27,000 | | $112,000 | $48,000 |
| Present Worth | $1,933,000 | | | $27,000 | | | $48,000 |

| ***Estimated Annual O&M Costs*** | | |
|---|---|---|
| Labor | $164,000 | |
| Power | $36,000 | |
| Maintenance and Supplies | $17,700 | |
| Natural Gas Purchase - entire plant | $85,000 | Note: added digester 2 heating |
| Additional biogas (cf/yr) | 27,684,000 | |
| Value of additional biogas, if gas is fully utilized | ($159,500) | |
| Chemicals for P removal | $34,000 | |
| Digested Liquid (gal/year) | 3,843,000 | |
| Digested Liquid Land Application Contractor | $115,000 | |
| Additional Supernatant (gal/year) | 5,100,000 | |
| Additional Supernatant Treatment at WWTP** | $66,300 | |
| Total | $359,000 | |
| Present Worth of O&M | $4,721,000 | |

| ***Summary of Present Worth Costs*** | | | |
|---|---|---|---|
| Capital Cost | $1,933,000 | | |
| Replacement | $27,000 | | |
| O&M Cost | $4,721,000 | | |
| Salvage Value | ($48,000) | | |
| **TOTAL PRESENT WORTH** | **$6,633,000** | | |
| Annualized PW | $504,000 | $300,000 | Approx. additional annual revenue required compared to status quo |
| | | $359 | per AU per year*** |

Notes:

All costs are fourth quarter 2009 dollars.

Present worth is calculated on a 20-year basis at discount rate shown.

*Additional funding, administration, pilot testing, etc. services included

**Supernatant treatment includes costs for additional power and phosphorus removal chemical.

***Assumes 836 animal units

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Digested liquid cost for land application | $0.03 | per gallon |
| Biogas value | $9.60 | per MMBTU |
| Supernatant treatment cost | $0.013 | per gallon |

## City of Whitewater Digestion Study
### Alternative DG4
### Agricultural Waste Digestion in Primary Digester No. 2 with Mixing

Discount Rate 4.38%

*Dewatering of digested solids*

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| Packaged Receiving Station | $174,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Ten Day Raw Storage | $176,000 | $0 | 30 | $0 | 10 | $0 | $0 |
| Submersible Pumps, Controls, Card Reader system | $42,000 | $19,000 | 15 | $10,000 | 15 | $28,000 | $12,000 |
| Primary Digester No. 2 Mixing Pumps | $103,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Primary Digester No. 2 Recirculation Pump | $34,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Liquid Digested Manure Storage (Lagoons - 90 days) | $290,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Liquid Pumping Station for Supernating and Hauling | $34,000 | $25,000 | 15 | $13,000 | 15 | $23,000 | $10,000 |
| Dewatering and Storage Building | $240,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Dewatering and Conveyance Equipment | $750,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Supernatant Pump and Meter - in 15 years | $0 | $7,500 | 15 | $4,000 | 15 | $5,000 | $2,000 |
| Subtotal | $1,843,000 | | | | | | |
| Piping/Mechanical (18%) | $332,000 | | | $0 | 30 | $111,000 | $47,000 |
| Electrical (15%) | $276,000 | | | $0 | 20 | $0 | $0 |
| HVAC (3%) | $55,000 | | | $0 | 20 | $0 | $0 |
| Sitework (5%) | $92,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $2,598,000 | | | | | | |
| Contractor's General Conditions (8%) | $208,000 | | | | | | |
| Total Construction Costs | $2,806,000 | | | | | | |
| Contingencies, Legal & Engineering Services (38%)* | $1,066,000 | | | | | | |
| Total Capital Costs | **$3,872,000** | $52,000 | | $27,000 | | $167,000 | $71,000 |
| Present Worth | $3,872,000 | | | $27,000 | | | $71,000 |

| ***Estimated Annual O&M Costs*** | | |
|---|---|---|
| Labor | $200,000 | |
| Power | $37,000 | |
| Maintenance and Supplies | $38,500 | |
| Natural Gas Purchase - entire plant | $85,000 | Note: added digester 2 heating |
| Additional biogas (cf/yr) | 27,684,000 | |
| Value of additional biogas, if gas is fully utilized | ($159,500) | |
| Chemicals for P removal and dewatering | $68,000 | |
| Digested Manure Land Application Contractor | $0 | |
| Additional Pressate (gal/year) | 6,250,000 | |
| Additional Pressate Treatment at WWTP** | $81,250 | |
| Total | $350,000 | |
| Present Worth of O&M | $4,602,000 | |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $3,872,000 |
| Replacement | $27,000 |
| O&M Cost | $4,602,000 |
| Salvage Value | ($71,000) |
| **TOTAL PRESENT WORTH** | **$8,430,000** |

| | | | |
|---|---|---|---|
| Annualized PW | $641,000 | $437,000 | Approx. additional annual revenue required compared to status quo |
| | | $523 | per AU per year*** |

Notes:

All costs are fourth quarter 2009 dollars.
Present worth is calculated on a 20-year basis at discount rate shown.
Assumes dewatered digested manure would be picked up for free. Sale is also a possibility.
*Additional funding, administration, pilot testing, etc. services included.
**Pressate treatment includes costs for additional power and additional phosphorus removal chemical.
***Assumes 836 animal units

| Unit cost assumptions: | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Digested liquid cost for land application | $0.03 | per gallon |
| Biogas value | $9.60 | per MMBTU |
| Pressate treatment cost | $0.013 | per gallon |

**City of Whitewater Digestion Study**
**Alternative BG1**
**Continue to Flare Biogas (Status Quo)**

Discount Rate 4.38%

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| NG Boiler Replacement - in 10 years | $0 | $106,000 | 10 | $69,000 | 30 | $71,000 | $30,000 |
| Subtotal | $0 | | | | | | |
| Piping/Mechanical (18%) | $0 | | | $0 | 30 | $0 | $0 |
| Electrical (15%) | $0 | | | $0 | 20 | $0 | $0 |
| HVAC (3%) | $0 | | | $0 | 20 | $0 | $0 |
| Sitework (5%) | $0 | | | $0 | 20 | $0 | $0 |
| Subtotal | $0 | | | | | | |
| Contractor's General Conditions (8%) | $0 | | | | | | |
| Total Construction Costs | $0 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $0 | | | | | | |
| Total Capital Costs | **$0** | $106,000 | | $69,000 | | $71,000 | $30,000 |
| Present Worth | $0 | | | $69,000 | | | $30,000 |

| ***Estimated Annual O&M Costs**** | |
|---|---|
| Labor | $0 |
| Power | $0 |
| Maintenance and Supplies | $0 |
| Total | $0 |
| Present Worth of O&M | $0 |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $0 |
| Replacement | $69,000 |
| O&M Cost | $0 |
| Salvage Value | ($30,000) |
| **TOTAL PRESENT WORTH** | **$39,000** |
| Annualized PW | $3,000 |

Notes:
All costs are fourth quarter 2009 dollars.
Present worth is calculated on a 20-year basis at discount rate shown.
*Baseline O&M costs are already included in DG1

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Natural Gas | $9.60 | per MMBTU |

## City of Whitewater Digestion Study

### Alternative BG2

### Biogas Utilization in Existing On-Site Boiler (Retrofit)

Discount Rate 4.38%

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| NG Boiler Replacement - in 10 years | $0 | $106,000 | 10 | $69,000 | 30 | $71,000 | $30,000 |
| Gas Compression/Moisture Removal | $270,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Boiler Retrofit - Burner and Gas Blending | $27,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Subtotal | $297,000 | | | | | | |
| Piping/Mechanical (18%) | $53,000 | | | $0 | 30 | $18,000 | $8,000 |
| Electrical (15%) | $45,000 | | | $0 | 20 | $0 | $0 |
| HVAC (3%) | $9,000 | | | $0 | 20 | $0 | $0 |
| Sitework/Building Rehab (5%) | $15,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $419,000 | | | | | | |
| Contractor's General Conditions (8%) | $34,000 | | | | | | |
| Total Construction Costs | $453,000 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $159,000 | | | | | | |
| Total Capital Costs | **$612,000** | $106,000 | | $69,000 | | $89,000 | $38,000 |
| Present Worth | $612,000 | | | $69,000 | | | $38,000 |

| ***Estimated Annual O&M Costs**** | |
|---|---|
| Labor | $18,200 |
| Power | $13,000 |
| Biogas Credit (if Digest Sludge Only) | ($37,000) |
| Maintenance and Supplies | $8,900 |
| Total | $3,000 |
| Present Worth of O&M | $39,000 |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $612,000 |
| Replacement | $69,000 |
| O&M Cost | $39,000 |
| Salvage Value | ($38,000) |
| **TOTAL PRESENT WORTH** | **$682,000** |
| Annualized PW | $52,000 |

Notes:

All costs are fourth quarter 2009 dollars.

Present worth is calculated on a 20-year basis at discount rate shown.

*Baseline O&M costs are already included in DG1.

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 3% | percent of equipment capital cost |
| Natural Gas | $9.60 | per MMBTU |

**City of Whitewater Digestion Study**
**Alternative BG3**
**Biogas Utilization in New On-Site Boiler**

Discount Rate 4.38%

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| NG Boiler Replacement - in 15 years (for standby) | $0 | $106,000 | 15 | $56,000 | 30 | $88,000 | $37,000 |
| Biogas Boiler (heater/heat exchanger) | $304,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Subtotal | $304,000 | | | | | | |
| Piping/Mechanical (20%) | $61,000 | | | $0 | 30 | $20,000 | $8,000 |
| Electrical (15%) | $46,000 | | | $0 | 20 | $0 | $0 |
| HVAC (5%) | $15,000 | | | $0 | 20 | $0 | $0 |
| Sitework/Building Rehab (5%) | $15,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $441,000 | | | | | | |
| Contractor's General Conditions (8%) | $35,000 | | | | | | |
| Total Construction Costs | $476,000 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $167,000 | | | | | | |
| Total Capital Costs | **$643,000** | $106,000 | | $56,000 | | $108,000 | $45,000 |
| Present Worth | $643,000 | | | $56,000 | | | $45,000 |

| ***Estimated Annual O&M Costs**** | |
|---|---|
| Labor | $18,200 |
| Power | $13,000 |
| Biogas Credit (if Digest Sludge Only) | ($37,000) |
| Maintenance and Supplies | $6,100 |
| Total | $0 |
| Present Worth of O&M | $0 |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $643,000 |
| Replacement | $56,000 |
| O&M Cost | $0 |
| Salvage Value | ($45,000) |
| **TOTAL PRESENT WORTH** | **$654,000** |
| Annualized PW | $50,000 |

Notes:
All costs are fourth quarter 2009 dollars.
Present worth is calculated on a 20-year basis at discount rate shown.
*Baseline O&M costs are already included in DG1

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Natural Gas | $9.60 | per MMBTU |

## City of Whitewater Digestion Study
### Alternative BG4
### Biogas Utilization at Cogentrix

Discount Rate 4.38%

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| NG Boiler Replacement - in 10 years | $0 | $106,000 | 10 | $69,000 | 30 | $71,000 | $30,000 |
| Gas Compression/Moisture Removal | $317,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Hydrogen Sulfide Removal | $138,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Siloxane Removal | $47,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Gas Storage: Repair and Rehab Sphere | $75,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Pipeline to Congentrix | $115,500 | $0 | 30 | $0 | 30 | $39,000 | $17,000 |
| Subtotal | $693,000 | | | | | | |
| Piping/Mechanical (18%) | $104,000 | | | $0 | 30 | $35,000 | $15,000 |
| Electrical (15%) | $87,000 | | | $0 | 20 | $0 | $0 |
| HVAC (3%) | $17,000 | | | $0 | 20 | $0 | $0 |
| Sitework (5%) | $35,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $936,000 | | | | | | |
| Contractor's General Conditions (8%) | $75,000 | | | | | | |
| Total Construction Costs | $1,011,000 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $354,000 | | | | | | |
| Total Capital Costs | **$1,365,000** | $106,000 | | $69,000 | | $145,000 | $62,000 |
| Present Worth | $1,365,000 | | | $69,000 | | | $62,000 |

***Estimated Annual O&M Costs****

| | |
|---|---|
| Labor | $18,200 |
| Power | $24,400 |
| H2S Media Replacement | $35,000 |
| Biogas Credit (if Digest Sludge Only) | ($24,000) |
| Maintenance and Supplies | $11,500 |
| Total | $65,000 |
| Present Worth of O&M | $855,000 |

***Summary of Present Worth Costs***

| | |
|---|---|
| Capital Cost | $1,365,000 |
| Replacement | $69,000 |
| O&M Cost | $855,000 |
| Salvage Value | ($62,000) |
| **TOTAL PRESENT WORTH** | **$2,227,000** |
| Annualized PW | $169,000 |

Notes:
All costs are fourth quarter 2009 dollars.
Present worth is calculated on a 20-year basis at discount rate shown.
*Baseline O&M costs are already included in DG1
Additional discussions with Cogentrix would be needed regarding allowable CO2 content, final purchase price, and other details.

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Natural Gas | $9.60 | per MMBTU |
| Biogas Purchase by Cogentrix (65% of above price) | $6.24 | per MMBTU |

## City of Whitewater Digestion Study
### Alternative BG5
### Biogas Utilization in Existing On-Site Generators

Discount Rate 4.38%

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| NG Boiler Replacement - in 10 years | $0 | $106,000 | 10 | $69,000 | 30 | $71,000 | $30,000 |
| Gas Compression/Moisture Removal | $284,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Hydrogen Sulfide Removal | $138,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Siloxane Removal | $47,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Gas Storage - Dystor BOG | $375,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Dual Fuel Regulator/Blending for Generator; Generator Cooling Improvements | $68,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Subtotal | $912,000 | | | | | | |
| Piping/Mechanical (18%) | $164,000 | | | $0 | 30 | $55,000 | $23,000 |
| Electrical (15%) | $137,000 | | | $0 | 20 | $0 | $0 |
| HVAC (3%) | $27,000 | | | $0 | 20 | $0 | $0 |
| Sitework (5%) | $46,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $1,286,000 | | | | | | |
| Contractor's General Conditions (8%) | $103,000 | | | | | | |
| Total Construction Costs | $1,389,000 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $486,000 | | | | | | |
| Total Capital Costs | **$1,875,000** | $106,000 | | $69,000 | | $126,000 | $53,000 |
| Present Worth | $1,875,000 | | | $69,000 | | | $53,000 |

| ***Estimated Annual O&M Costs**** | |
|---|---|
| Labor | $18,200 |
| Power | $8,200 |
| H2S Media Replacement | $35,000 |
| Biogas Credit (if Digest Sludge Only)** | ($37,000) |
| Maintenance and Supplies | $16,900 |
| Total | $41,300 |
| Present Worth of O&M | $543,000 |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $1,875,000 |
| Replacement | $69,000 |
| O&M Cost | $543,000 |
| Salvage Value | ($53,000) |
| **TOTAL PRESENT WORTH** | **$2,434,000** |
| Annualized PW | $185,000 |

Notes:

All costs are fourth quarter 2009 dollars.
Present worth is calculated on a 20-year basis at discount rate shown.
Assumes operation of gas treatment equipment and generators 8 hr/day only (store "raw" biogas)
Additional discussions with Generac would be needed regarding allowable CO2 content and continuous operation of generators for 8 hr/day
Note some emission controls may be required for non-emergency use of generator
*Baseline O&M costs are already included in DG1

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Natural Gas | $9.60 | per MMBTU |

# City of Whitewater Digestion Study
## Alternative BG6
**Biogas Utilization in New On-Site Microturbine(s)** Discount Rate 4.38%

*One Microturbine Assumed*

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| NG Boiler Replacement - in 10 years | $0 | $106,000 | 10 | $69,000 | 30 | $71,000 | $30,000 |
| Gas Compression/Moisture Removal | $284,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Hydrogen Sulfide Removal | $138,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Siloxane Removal | $47,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Gas Storage - Dystor BOG | $250,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Microturbines (1 initially - if digest sludge only) | $142,000 | $131,000 | 10 | $85,000 | 10 | $0 | $0 |
| Subtotal | $861,000 | | | | | | |
| Piping/Mechanical (18%) | $155,000 | | | $0 | 30 | $52,000 | $22,000 |
| Electrical (15%) | $129,000 | | | $0 | 20 | $0 | $0 |
| HVAC (3%) | $26,000 | | | $0 | 20 | $0 | $0 |
| Sitework (5%) | $43,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $1,214,000 | | | | | | |
| Contractor's General Conditions (8%) | $97,000 | | | | | | |
| Total Construction Costs | $1,311,000 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $459,000 | | | | | | |
| Total Capital Costs | **$1,770,000** | $237,000 | | $154,000 | | $123,000 | $52,000 |
| Present Worth | $1,770,000 | | | $154,000 | | | $52,000 |

| ***Estimated Annual O&M Costs**** | |
|---|---|
| Labor | $18,200 |
| Power | $24,400 |
| H2S Media Replacement | $35,000 |
| Natural gas credit from waste heat recovery | ($8,410) |
| Microturbine Factory Protection Plan | $7,000 |
| Power Sale to Grid (if Digest Sludge Only) | ($43,000) |
| Maintenance and Supplies | $14,400 |
| Total | $47,590 |
| Present Worth of O&M | $626,000 |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $1,770,000 |
| Replacement | $154,000 |
| O&M Cost | $626,000 |
| Salvage Value | ($52,000) |
| **TOTAL PRESENT WORTH** | **$2,498,000** |
| Annualized PW | $190,000 |

Notes:

All costs are fourth quarter 2009 dollars.

Present worth is calculated on a 20-year basis at discount rate shown.

*Baseline O&M costs are already included in DG1

Capstone rep indicates H2S removal may not be required; if so, capital cost would be reduced to $1.5 million.

Power sale price would need to be confirmed with We Energies; special 2010 promotional rate is shown.

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Power sale back to grid | $0.095 | per kwh (special promotion from We Energies) |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Natural Gas | $9.60 | per MMBTU |

# APPENDIX C
# OPINION OF COST FOR RECOMMENDED PLAN

## City of Whitewater Digestion Study
### Alternative DG2 - B and BG3
### Municipal Biosolids Digestion Plus Industrial Waste in Digester 1 and Biogas Utilization in New On-Site Boiler

Discount Rate 4.38%

| ITEM | Initial Capital Cost | Replacement Cost | Replacment Interval (Yr) | Replacement P.W. | Service Life | 20 yr Salvage Value | Salvage Value (P.W.) |
|---|---|---|---|---|---|---|---|
| Offloading station | $44,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Holding Tank | $54,000 | $0 | 30 | $0 | 10 | $0 | $0 |
| Submersible Pumps, Controls, Card Reader system | $42,000 | $38,889 | 15 | $20,000 | 15 | $28,000 | $12,000 |
| Supernatant Pump and Meter - in 15 years | $0 | $7,500 | 15 | $4,000 | 15 | $5,000 | $2,000 |
| NG Boiler Replacement - in 15 years (for standby) | $0 | $106,000 | 15 | $56,000 | 30 | $88,000 | $37,000 |
| Biogas Boiler (heater/heat exchanger) | $304,000 | $0 | 20 | $0 | 20 | $0 | $0 |
| Subtotal | $444,000 | | | | | | |
| Piping/Mechanical (21%) | $93,000 | | | $0 | 30 | $31,000 | $13,000 |
| Electrical (17%) | $75,000 | | | $0 | 20 | $0 | $0 |
| HVAC (5%) | $22,000 | | | $0 | 20 | $0 | $0 |
| Sitework Including Driveway and Gate | $35,000 | | | $0 | 20 | $0 | $0 |
| Subtotal | $669,000 | | | | | | |
| Contractor's General Conditions (8%) | $54,000 | | | | | | |
| Total Construction Costs | $723,000 | | | | | | |
| Contingencies, Legal & Engineering Services (35%) | $253,000 | | | | | | |
| Total Capital Costs | **$976,000** | $152,000 | | $80,000 | | $152,000 | $64,000 |
| Present Worth | $976,000 | | | $80,000 | | | $64,000 |

| ***Incremental Estimated Annual O&M Costs*** | |
|---|---|
| Labor | $23,200 |
| Power | $13,000 |
| Maintenance and Supplies | $18,100 |
| Natural Gas Savings - after biogas utilization | ($54,000) |
| Additional Sludge (gal/year) | 911,000 |
| Additional Sludge Handling and Disposal | $45,600 |
| Additional Supernatant (gal/year)* | 6,388,000 |
| Additional Supernatant Treatment at WWTP** | $83,000 |
| Total | $129,000 |
| Present Worth of O&M | $1,696,000 |

| ***Summary of Present Worth Costs*** | |
|---|---|
| Capital Cost | $976,000 |
| Replacement | $80,000 |
| O&M Cost | $1,696,000 |
| Salvage Value | ($64,000) |
| **TOTAL PRESENT WORTH** | **$2,688,000** |
| Annualized PW | $204,000 |
| Revenue Required ($/1000 gallons waste accepted)* | $28 |

Notes:
All costs are fourth quarter 2009 dollars.
Present worth is calculated on a 20-year basis at discount rate shown.
Would need to reduce waste acceptance to 40% by 2030 or would need additional storage (Digester 2) for 2030*
*Assumes 20,000 gpd waste in at 5,000 lb/day COD and 2,500 gpd sludge produced (remainder is supernatant)
**Supernatant treatment includes costs for additional power and phosphorus removal chemical.

Unit cost assumptions:

| | | |
|---|---|---|
| Labor | $35 | per hour |
| Power | $0.07 | per kwh |
| Maintenance and Supplies | 2% | percent of equipment capital cost |
| Additional sludge handling and disposal | $0.05 | per gallon |
| Biogas value | $9.60 | per MMBTU |
| Supernatant treatment cost | $0.013 | per gallon |